AD-A069 222 KEARNEY (A T) INC CHICAGO IL CAYWOOD-SCHILLER DIV F/G 15/7
PACAM IV MULTIPLE AIRCRAFT THREE DIMENSIONAL AIR-TO-AIR COMBAT.--ETC(U)
APR 78 M D DLOOGATCH, D H SCHILLER F08635-77-C-0168

UNCLASSIFIED NL

1 OF 2
AD
A069222

1 OF 2

AD A069222

AD A069222

DDC FILE COPY

CAYWOOD-SCHILLER DIVISION
A. T. KEARNEY, INC.
100 South Wacker Drive
Chicago, Illinois 60606

LEVEL II

12 106p.

6 PACAM IV

MULTIPLE AIRCRAFT THREE DIMENSIONAL

AIR-TO-AIR COMBAT,

USER'S MANUAL,

10 Michael A. Dloogatch
Donald H. Schiller

DDC
RECEIVED
JUN 1 1979
A

11 Apr[redacted]78

15 F08635-77-C-0168

DISTRIBUTION STATEMENT A
Approved for public release;
Distribution Unlimited

Prepared For:

ARMAMENT DEVELOPMENT AND TEST CENTER, XRO
ELGIN AIR FORCE BASE, FLORIDA

79 05 29 125
406 851

DISCLAIMER NOTICE

THIS DOCUMENT IS BEST QUALITY PRACTICABLE. THE COPY FURNISHED TO DDC CONTAINED A SIGNIFICANT NUMBER OF PAGES WHICH DO NOT REPRODUCE LEGIBLY.

TABLE OF CONTENTS

79 05 29 125

LIST OF FIGURES

ACCESSION for
NTIS White Section
DDC Buff Section
UNANNOUNCED
JUSTIFICATION Per acq Sheet RTA 1164
BY
DISTRIBUTION/AVAILABILITY CODES
Dist. AVAIL. and/or SPECIAL
A 23 80

LIST OF INPUT FORMS

SECTION 1
PURPOSE

PACAM IV is a computer model, developed to assist in the evaluation of air-to-air armaments by simulating the performance of aircraft and weapons in aerial combat. This volume is intended to provide sufficient information to an analyst to collect and enter all data necessary to successfully run the PACAM IV Model.

This model has been developed from a previous version, PACAM II, by an evolutionary process. Section 2 below describes the model structure briefly, together with a discussion of the features available in the present version. Section 3 presents the necessary information and background to run the computer program. Section 4 describes the various output options and formats so that the analyst can understand and assess the results of computer runs. Section 5 briefly describes the system requirements for operation.

An appendix lists the FORTRAN FORMAT statements corresponding to the input forms.

Updates to this User's Manual will be issued periodically, as occasioned by changes to the computer programs. The user should endeavor to make certain that his version of the User's Manual corresponds to the version of the program actually being used.

SECTION 2

GENERAL DESCRIPTION OF PACAM IV

PACAM IV has been developed from a series of earlier versions as an evolutionary process, and a convenient way to describe the features of the present system is to describe this evolution.

PACAM I was originally prepared for ASD/XR commencing in 1968, and was designed to simulate one-vs-one aerial combat in three dimensional space. Both sides used the same tactics, and both used the same policy, i.e., fully aggressive. A limited maneuver suite was available, and each aircraft fought unaware of weapon usage by his foe. The resulting flight path data for the two aircraft were stored on tape to permit the subsequent evaluation of weapon firing opportunities. Under the auspices of ADTC/XR the evaluation program was expanded to include the flyout of missiles against the stored flight path of the target aircraft and an evaluation of the end results provided. PACAM I was then utilized as a system of three separate models: Model B (duel), Model E (weapons) and Model D (evaluation).

In order to overcome some of the limitations in the PACAM I system and to provide a model more useful for the aerial missile program at Eglin AFB, the development of PACAM II was started. Although the program was completely rewritten for efficient operation and ease of input, the major thrust was in the area of tactics. Asymmetric tactics were permitted in that each

side was allowed different decisions under various conditions and the level of aggressiveness was incorporated. Nonaggressive (escape) tactics by reason of position, as well as for low fuel conditions, were included. The simplistic decision process of the earlier model was replaced by a decision table approach that lends itself to further expansion as additional tactics are incorporated. Finally, and most significantly, the model was designed to permit multi-aircraft combat, and several tactical routines were developed for this purpose. Several of these tactical routines, and the user-supplied decision tables necessary to implement them are described in this manual.

PACAM II still utilized the partitioned model concept (B,E,D), which implies that maneuvering, both offensive and defensive, is independent of weapon firing. This limitation, plus a number of additional requirements leveled by various users was the impetus for the construction of the present version, namely PACAM IV.

The principal thrust of PACAM IV development was to permit dynamic reaction to weapons firing, with all the concomitant effects. In order to accomplish this goal, it was necessary to merge the three models described above (duel, weapons, evaluation) into a single program and provide additional subroutines to allow their interaction. First, the screening program was incorporated into the duel programs so as to evaluate firing opportunities for each of four weapons types (two missile types,

lasers, guns) on each aircraft at each time pulse. Optional firing doctrines then permit the choice of firing at first opportunity, or waiting if conditions are predicted to be improving.

For the case of missiles, a launch routine enters the missile into a list of active vehicles. Its path is then integrated along with the aircraft, so long as the missile remains viable. Presently, up to ten vehicles (aircraft and missiles) may be handled at one time. Weight and drag are decremented from the launching aircraft. If the missile is detected, the target aircraft may choose to evade the missile, changing the subsequent course of the battle. The program also contains a missile evaluation routine, which checks at each time pulse for break lock and/or closest approach to target. An end game routine determines whether or not a kill has been made. If so, the target is removed, aircraft roles are reassigned, and combat continued in a manner different than before. Similar dynamic evaluation is provided for gun and laser weapons, if present on the aircraft.

These dynamic weapons provisions, plus the desire by the LEAPS office at Kirtland AFB to use PACAM for bomber defense evaluation, led to another series of changes. First, size variations (from B-52 down to AIM-9) required that detection range be made a function of target size and aspect, as well as type of sensor. Second, this size variation, plus the

requirement of a smaller time pulse during missile flyout, led to a requirement for vehicle response rate limitations (roll, pitch, thrust) which effectively permit simulation of 5 DOF movement.

The concepts of kill evaluation, and action based upon missile detection led to requests for stochastic determination of these variables, and this is provided in PACAM IV, by an optional Monte-Carlo routine.

Finally, bomber penetration and defense tactics are available, together with tail defense weapon screening, firing and evaluation. (Fighter tactics against the bomber were well handled within the framework of the existing tactical routines.)

Evolution of the program has been accompanied by evolution of the display modes, progressing through the plotted output shown in this manual to integral movie preparation, as provided by the Computer Center at Kirtland AFB.

PACAM IV is written in FORTRAN IV, and comprises some 60 subroutines. Versions of the PACAM programs are presently operational at the following locations: Eglin AFB, Kirtland AFB, Wright-Patterson AFB, China Lake NWC and RAE Farnsborough.

SECTION 3

OPERATING INSTRUCTIONS

3.1 INTRODUCTION

This section of the PACAM IV User's Manual is intended to enable the prospective user to prepare inputs for the PACAM IV computer program. A full discussion is provided of input formats, and limitations and restrictions on the inputs.

The aircraft may be armed with any combination of four basic weapon types: long-range missile, short-range missile, laser and gun. A magnetic tape is produced which describes the resulting flight paths. This tape can be used to provide computer generated plots of the combat. Also produced are printed reports which describe the flight paths, weapon firing opportunities, weapon firings and resulting aircraft or missile kills.

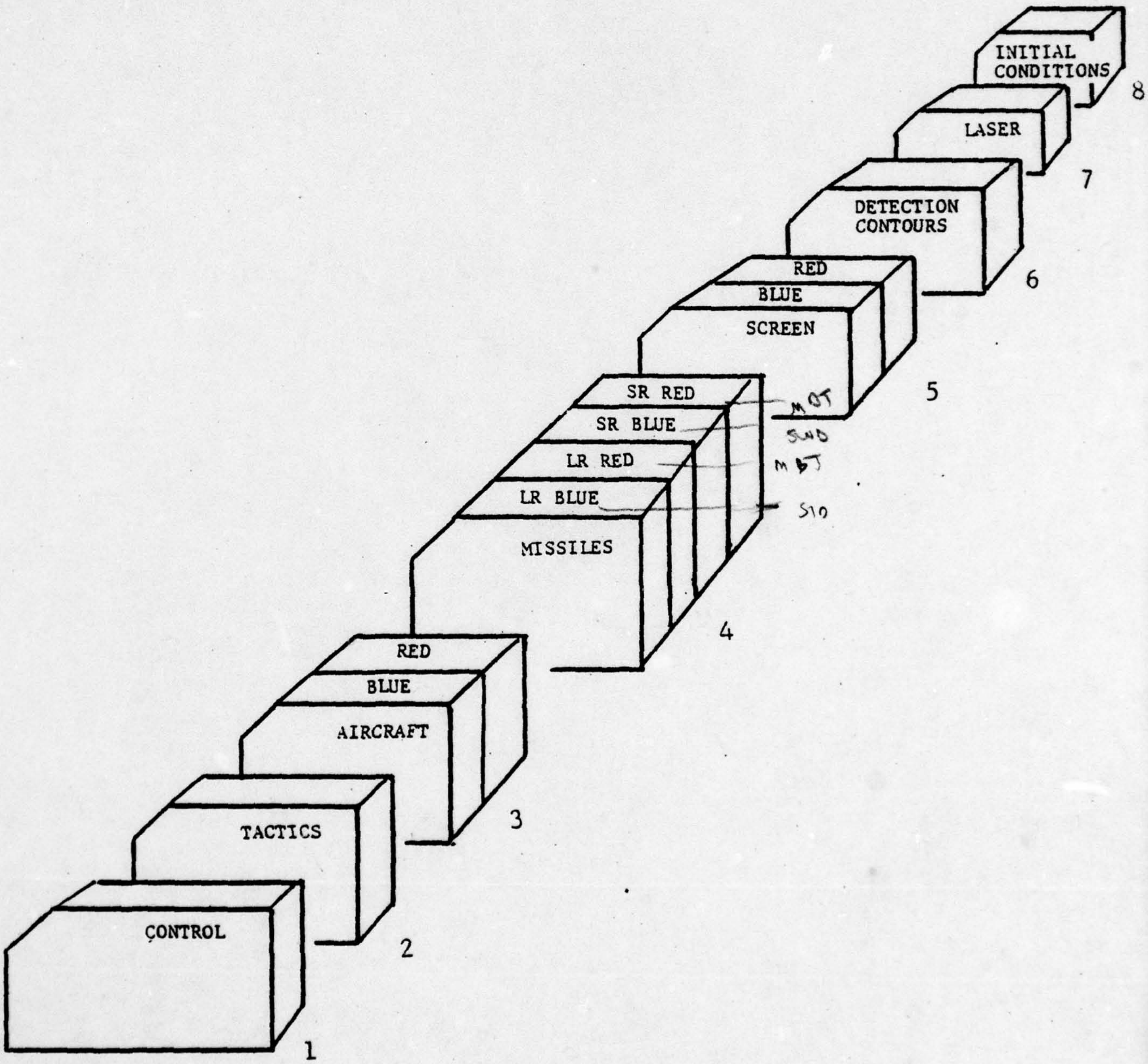
3.2 INPUTS

There are eight categories of inputs for PACAM IV which are discussed fully below. These inputs must be supplied as punched cards or card images on disk or tape. The input forms presented in this section are meant to serve as keypunch layout sheets. After they have been completely filled out, they can be submitted to a keypuncher with instructions to punch a card for every line on the form which has data entered. The cards which result from this process can be read directly by the program in the order in which they are treated in the following discussion.

This order is pictured in Figure 3-1. There is no automatic sequence checking of the inputs by the program so the user must take care that the input cards remain in the order specified. There are several sets of input cards which contain information that is needed only when the user chooses to exercise certain special options (e.g., double attack tactics, bomber defense tactics) are selected. These cards are required whether or not the options are selected, but blank cards may be used if the information is not needed.

FIGURE 3-1

REQUIRED INPUT ORDER



3.2.1 CONTROL CARDS

The first two input cards required are the control cards shown on Form 1. The first of these two cards is used to identify a set of runs. Only the denoted 16 characters of alphanumeric information on the card are used for this purpose. The second card contains the following control parameters affecting the entire set of runs.

NAC	- the number of aircraft involved in an engagement (as the model is presently constituted, this must be either 2 or 3 or 4).
NTYPE	- the number of aircraft types for which data is to be read in (1 or 2).
NRUNS	- the number of runs in the current set. (Must agree with number of sets of initial condition cards).
INDMC	- indicator for whether or not initial detection range is determined by a Monte Carlo process; 0=no, 1=yes.
INDRCT	- indicator for whether or not a target aircraft reacts to the firing of a missile by opponent; 0=no, 1=yes.
TMAX	- maximum time through which an engagement lasts. (seconds)
DLT1	- time increment for integration when no missile is in air and no laser or gun is being fired. (seconds) (Must be 1.0, 0.5, or 0.1)
DLT2	- time increment for integration when missile is in air or laser or gun is firing. (seconds) (must be 0.1 or 0.01.)

FORMATS (see appendix)

LINES 1,2 FORMAT (2A10/5I5,3F10.0)

3.2.2 TACTICAL PARAMETERS

The input forms for tactical parameters are Form 2 and Form 3. These forms allow for completely independent tactics on the part of each of two sides involved in the combat. Thus, for example, the fact that an aircraft on one side is on the offensive does not necessarily mean that its opponent must react in a defensive mode.

The first line of Form 2 asks for the following inputs.

NOSIDE - the number of aircraft on the side.

ITAC - the type of tactics being employed by the side. Permissible entries are:

- SN - single aircraft
- *FE - free and engaged
- WW - welded wing
- *DA - double attack
- BD - bomber defense

ISTURN - indicator for whether or not an aircraft is to perform 30° clearing turns when in Maneuver State 5; 0=no, 1=yes.

IHOLD - indicator for whether an aircraft fires at the earliest opportunity or holds fire while conditions seem to be improving; 0=fire at once, 1=hold.

In order to prepare the tactical parameters which come next on Form 2 the user must be familiar with the concept of the tracking angle plot. The tracking angle of an aircraft with respect

---

* NOTE: In the current version of PACAM IV, if one side is using either FE or DA, the other side must be using either SN, BD, or WW.

Kearney: Management Consultants

FORM 2

TACTICAL INPUTS

FORM 02

ISIDE = 1

NOSIDE XTAC ISTURN IHOLD

ACTION PRIORITY

ATTACK 1

OFFENSE 2

DEFENSE 1 3

DEFENSE 2 4

DEFENSE 3 5

DEFENSE 4 6

RLIM TAU1 TAU2

ESC ALT ESC MACH OVER TAKE MAX LAG FORMATION XLF YLF

ISIDE = 2

NOSIDE XTAC ISTURN IHOLD

PRIORITY

RLIM TAU1 TAU2

ESC ALT ESC MACH OVER TAKE MAX LAG FORMATION XLF YLF

BOMBER PENETRATION POINTS

FIRST POINT

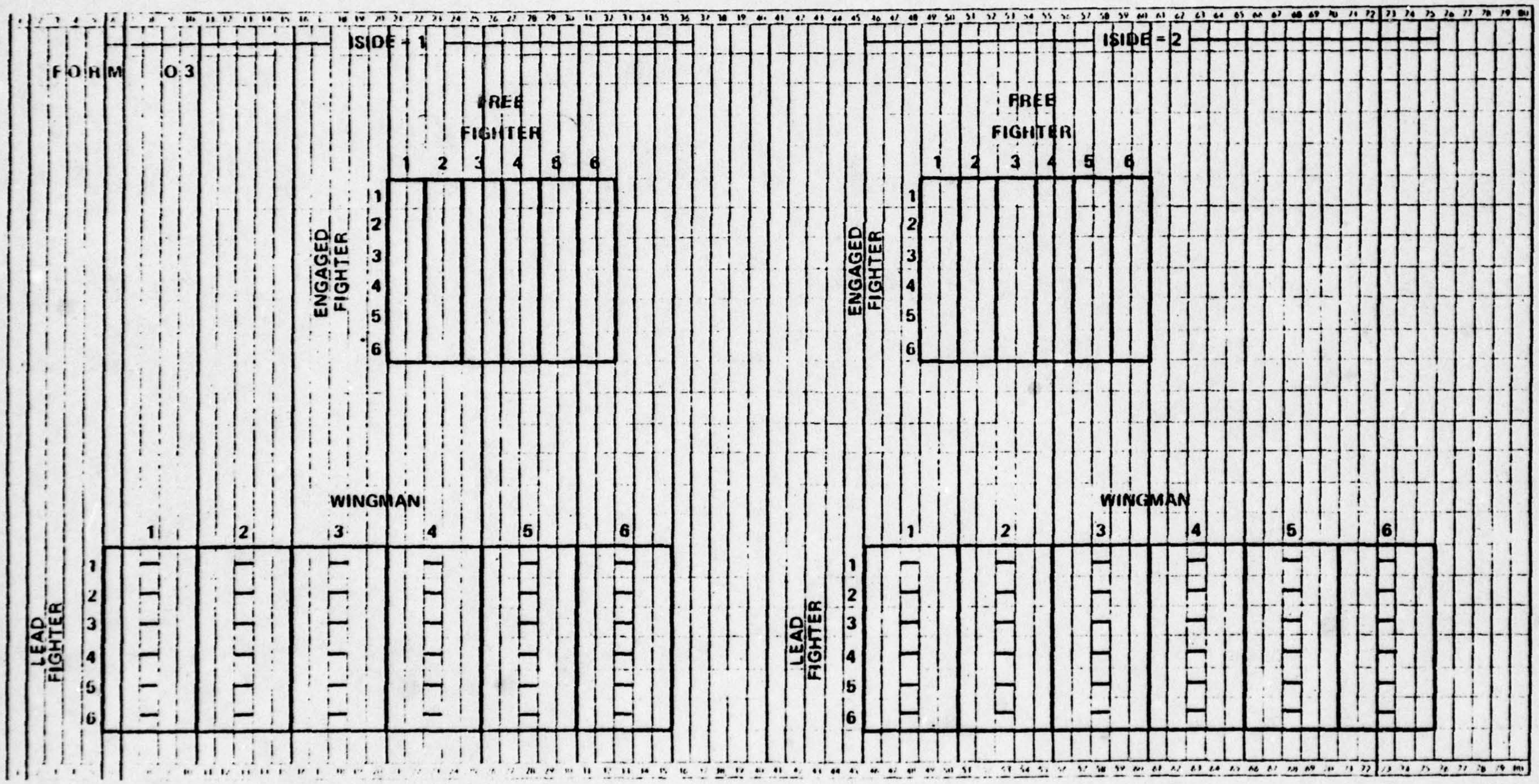
XPEN YPEN ZPEN VPEN

SECOND POINT

XPEN YPEN ZPEN VPEN

FORM 3

TACTICAL INPUTS



to another is defined to be the angle between the velocity vector of that aircraft and the line-of-sight vector. For any pair of aircraft, then, there is a pair of tracking angles (τ_1, τ_2) which together with the range, can be used to describe their relative positions in space. This concept is often used intuitively when dogfights are discussed, as illustrated in Figure 3-2.

In Figure 3-3 is shown a simplified tracking angle plot. On this plot τ_1 represents the tracking angle of aircraft 1 and τ_2 is the tracking angle of aircraft 2. Note that the square:

$$0 \leq \tau_1 \leq 180, \; 0 \leq \tau_2 \leq 180$$

is a boundary of the region of interest as no other values for the tracking angle may occur.

In a multiple aircraft combat a tracking angle plot can be constructed from the point of view of each aircraft in the combat, as illustrated in Figure 3-4. If the plot is from the point of view of an aircraft which has more than one opponent, then all opponents appear on the plot as shown in Figure 3-5. In these plots the τ_1 axis measures the tracking angle of the aircraft (not necessarily aircraft 1) with respect to its opponent, and the τ_2 axis measures the tracking angle of the opponent with respect to the aircraft.

The parameters on Form 3 under the headings TAU1 and TAU2 are used to partition the tracking angle plot into four defensive regions. Each region is defined as that portion of the

FIGURE 3-2

INTUITIVE MEANING OF TRACKING ANGLE

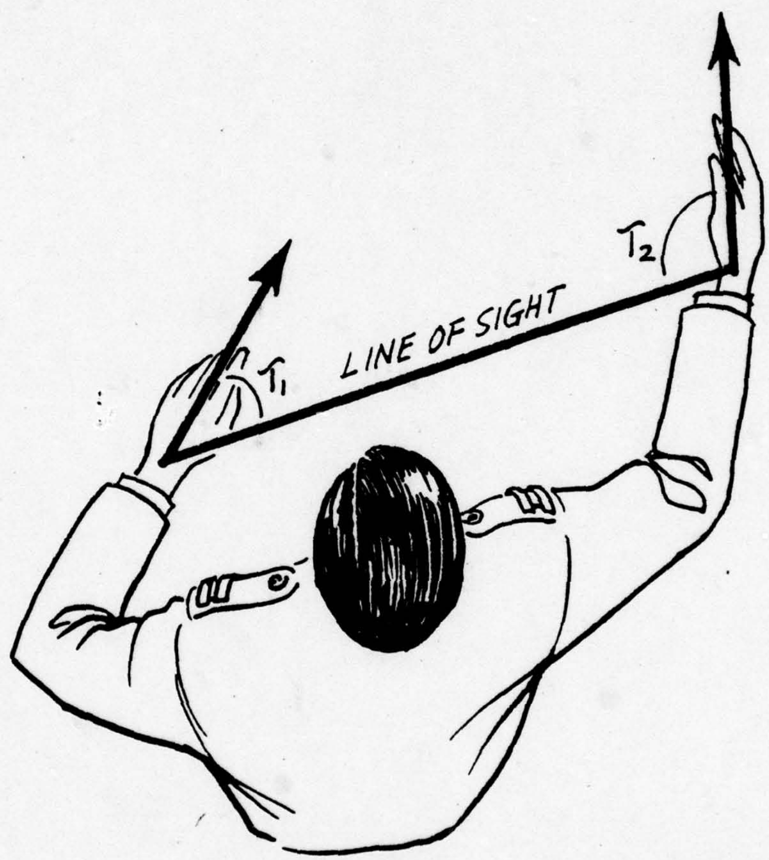


FIGURE 3-3

TRACKING ANGLE PLOT COORDINATES

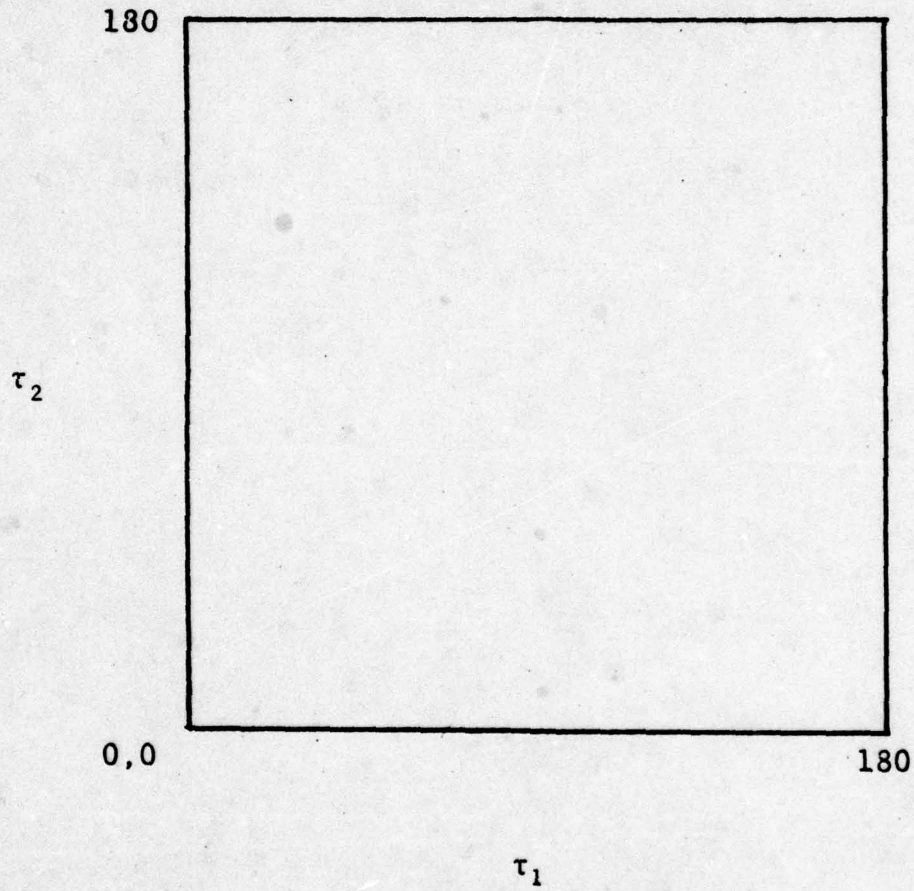
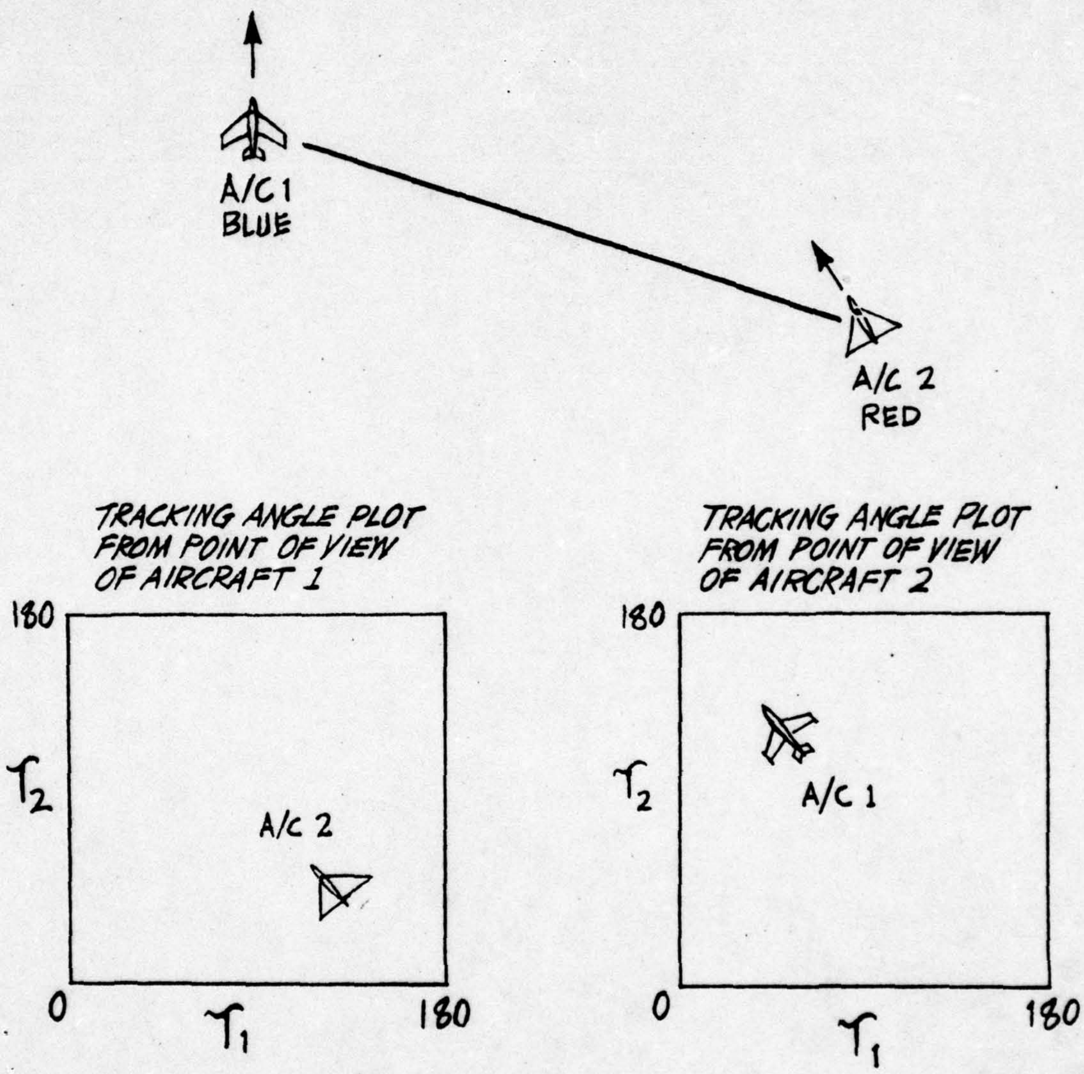


FIGURE 3-4

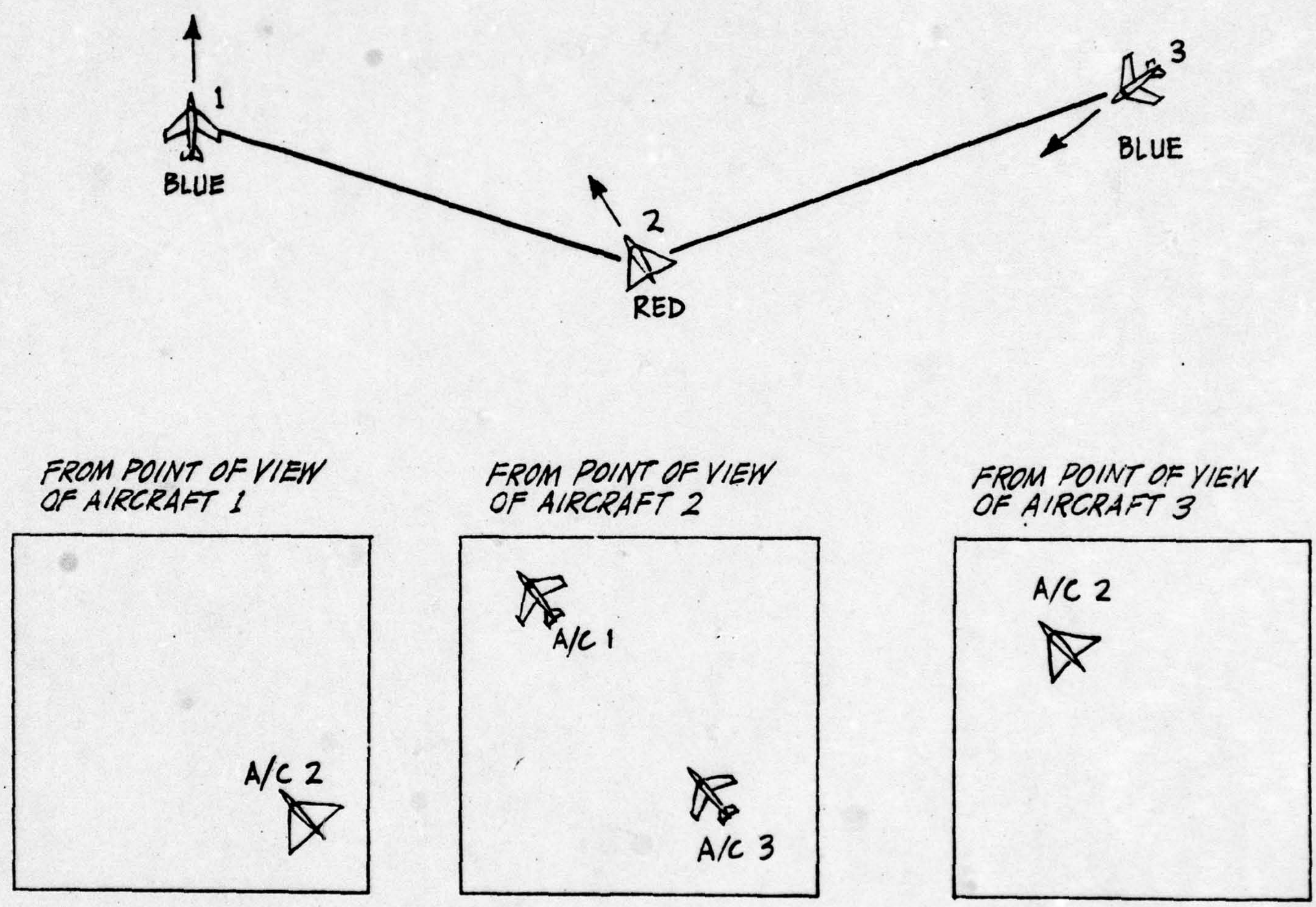
TRACKING ANGLE PLOTS FOR TWO AIRCRAFT:
INSTANTANEOUS PICTURE



Note: Orientation of A/C symbol in plot is not significant.

FIGURE 3-5

TRACKING ANGLE PLOTS FOR THREE AIRCRAFT:
INSTANTANEOUS PICTURE



the tracking angle plot for which $\tau_1 \geq$ TAU1 and $\tau_2 \leq$ TAU2. The parameter RLIM allows for a range restriction on each of the four defensive zones. The zones need not be nested either with respect to range limits or angular limits. If an opponent lies within the limits of two or more zones it is considered to be within the lowest numbered zone.

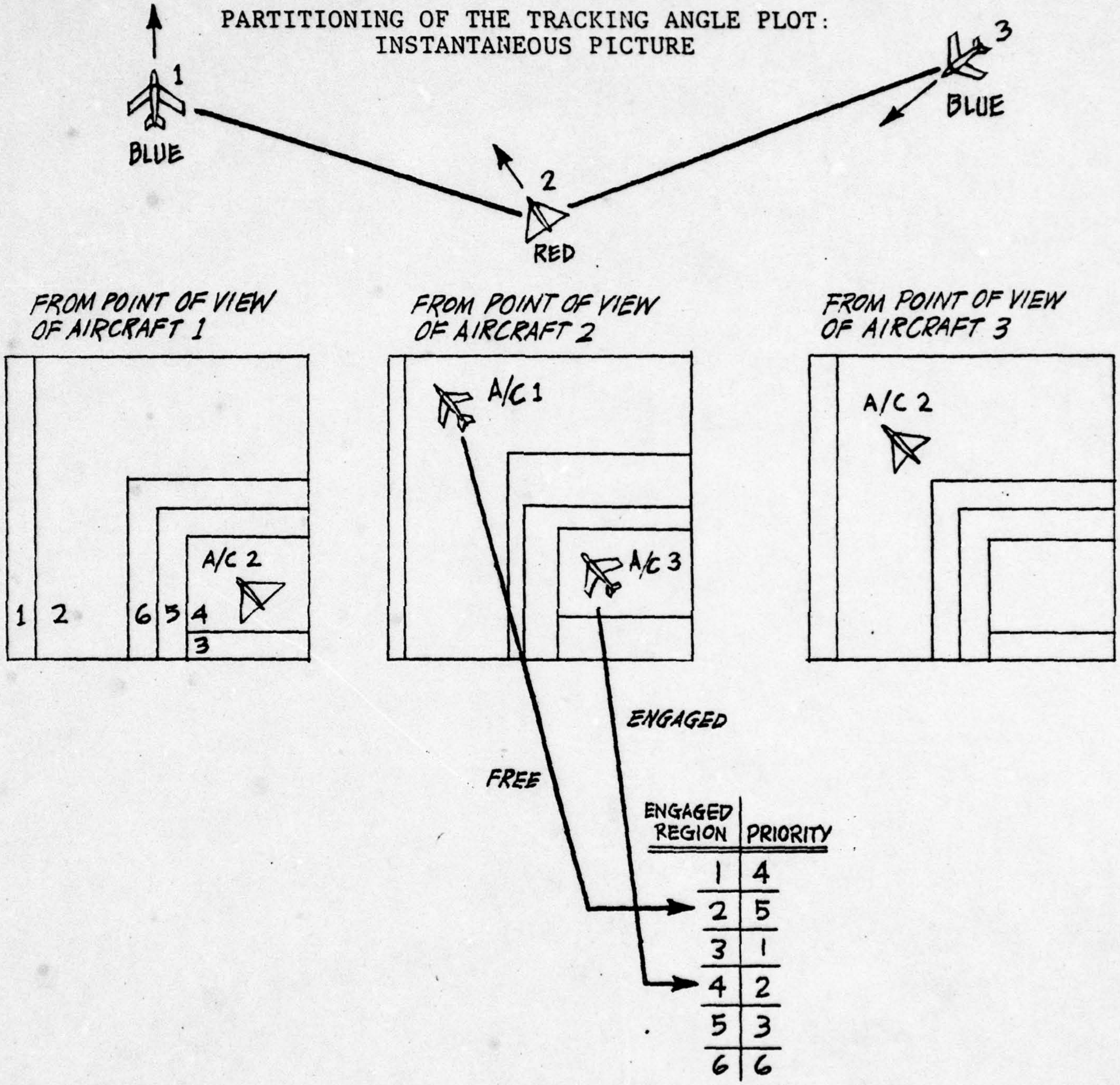
On the plot for aircraft 1, in Figure 3-6, these regions are labeled 3, 4, 5, and 6, which numbers also appear on Form 3 under the heading ACTIONS. These numbers establish the correspondence between each region and the action to be taken by an aircraft should an opponent appear in that region of the tracking angle plot. An explanation of these actions and their equivalent maneuver states appears in Section 4.4.1 of this report.

If the range is greater than the largest RLIM, then the aircraft is on "offense." If an aircraft is on "offense," it is either in an attack position (i.e., on or near a pursuit course) or trying to get to one. These states correspond to the regions labeled 1 and 2 in Figure 3-6.

In the case of a single aircraft which has two opponents, it is necessary for the single aircraft to decide to which of the two opponents to react. This is accomplished by assigning priorities to each of the six regions (i.e., attack, offense, and four defensive regions). The opponent with the highest

FIGURE 3-6

PARTITIONING OF THE TRACKING ANGLE PLOT:
INSTANTANEOUS PICTURE



priority is called the engaged fighter. The other opponent is called the free fighter (See Figure 3-6). Both opponents are assumed to know both designations. If both opponents are in the same zone the program presently assigns the closest one as engaged. On the input form the column headed PRIORITY must be filled with integers between 1 and 6 with 1 being the highest priority and 6 the lowest.

The next row of inputs requires the following entries:

ESC ALT - The altitude to which an aircraft attempts to climb in defense zone 4. (feet)

ESC MACH - That mach number at which an aircraft in defense zone 4 attempts to climb to escape altitude.

OVERTAKE - That speed in which an aircraft on pursuit course attempts to close with the target. (feet/second)

MAX LAG - The maximum angle in by which a pursuing aircraft may attempt to lag a true pursuit course. (degrees) (This maximum would be attempted only for head-on case.)

XLF - The distance directly behind a lead aircraft that an aircraft flying formation will attempt to maintain. (feet)

YLF - The distance to the left or right of a lead aircraft that an aircraft flying formation will attempt to maintain. (feet)

The last row on Form 2 reads in the parameters for bomber penetration. These values are used only if one side is using bomber defense tactics -- otherwise, a blank card may be read in. They define the course which a bomber will attempt to

follow when it is not taking evasive action. Initially, the bomber flies a course for the first of two penetration prints. If it is forced sufficientl off this course by an attacking fighter, it attempts to fly to the second point. The X and Y inertial coordinates (XPEN and YPEN) for each point must be entered, and also the altitude (ZPEN) and speed (VPEN) at which the course is to be flown to that point.

Another concept with which the user must be familiar in order to input tactical parameters is the distinction between "posture" and "action." As used here the posture of one aircraft with respect to an opponent is defined in terms of the opponent's position on the aircraft's tracking angle plot. The posture is given a numerical value between 1 and 6 based on the numbered regions shown in Figure 3-6. These six postures are defined as follows.

Code	Posture
1	On or near pursuit course
2	Attempting to get to pursuit course
3	Opponent in Defense Zone 1
4	Opponent in Defense Zone 2
5	Opponent in Defense Zone 3
6	Opponent in Defense Zone 4

Based on posture and certain other considerations a decision must be made as to what action each aircraft will follow. Some of the other considerations are: fuel remaining, position of partner, position of opponent's partner and lack of awareness

of opponent. The following actions are possible:

Code	Action
1	Lead pursuit for gun firing
2	Offensive turn to get to pursuit course
3	Defensive action 1
4	Defension action 2
5	Defensive action 3
6	Defensive action 4
7	Continue unaware
8	Fly formation with partner
9	Attempt to bracket opponent
10	Out of combat due to being shot down
11	Evade missile
12	Disengage due to bingo fuel
13	Disengage
14	Chandelle
15	Split-S
16	Immelman
17	High speed yo-yo
18	Barrel roll
19	Bomber penetration
20	Bomber defensive action

3.2.2.1 FREE-ENGAGED ACTION TABLE

For a side using free-engaged tactics, a table must be supplied by the user which determines the free fighter's action based on the posture of the engaged fighter. (The action of the engaged fighter does not depend on the posture of the free fighter.) This table for free fighter actions must be filled in on Form 3. The 36 entries in the table specify the actions to be taken by the free fighter as a function of his own posture and the posture of his partner. All of the action codes defined on the previous page are possible entries in this table, but some will probably not make sense as tactics. Codes 7, 10, 11, 12, 17, 19 and 20 for example, refer to actions which are

assigned internally by the program as a result of special conditions.

Figure 3-7 displays a typical way the free-engaged action table might be filled out and can be interpreted as follows. The first row is all 9's. This means that if the engaged fighter is close to a pursuit course, the free fighter will attempt to come around and bracket the opponent, even if the current geometry of the situation is such that the free fighter would be in a defensive state if he were to ignore his partner. The fifth row spells out the actions followed by the free fighter given that the engaged fighter has a posture of 5, which corresponds to seeing the opponent in defensive zone 3. The entry 1 in column 1 means that if the free fighter is already on a gun-firing pursuit course, it will continue that action. The 2 in column 2 specifies that if the free fighter is already in an offensive situation and striving to get to a pursuit course, it will continue that course of action. The entries in columns 3 and 4, however, mean that because the opponent is concentrating on the engaged fighter, the free fighter will ignore its defensive posture and attempt to get on the offensive and "sandwich" the opponent. The fifth and sixth columns say that the free fighter will remain in its defensive position. Figure 3-8 represents the complete tactical logic of the three aircraft at each point in time. An instantaneous picture is also shown.

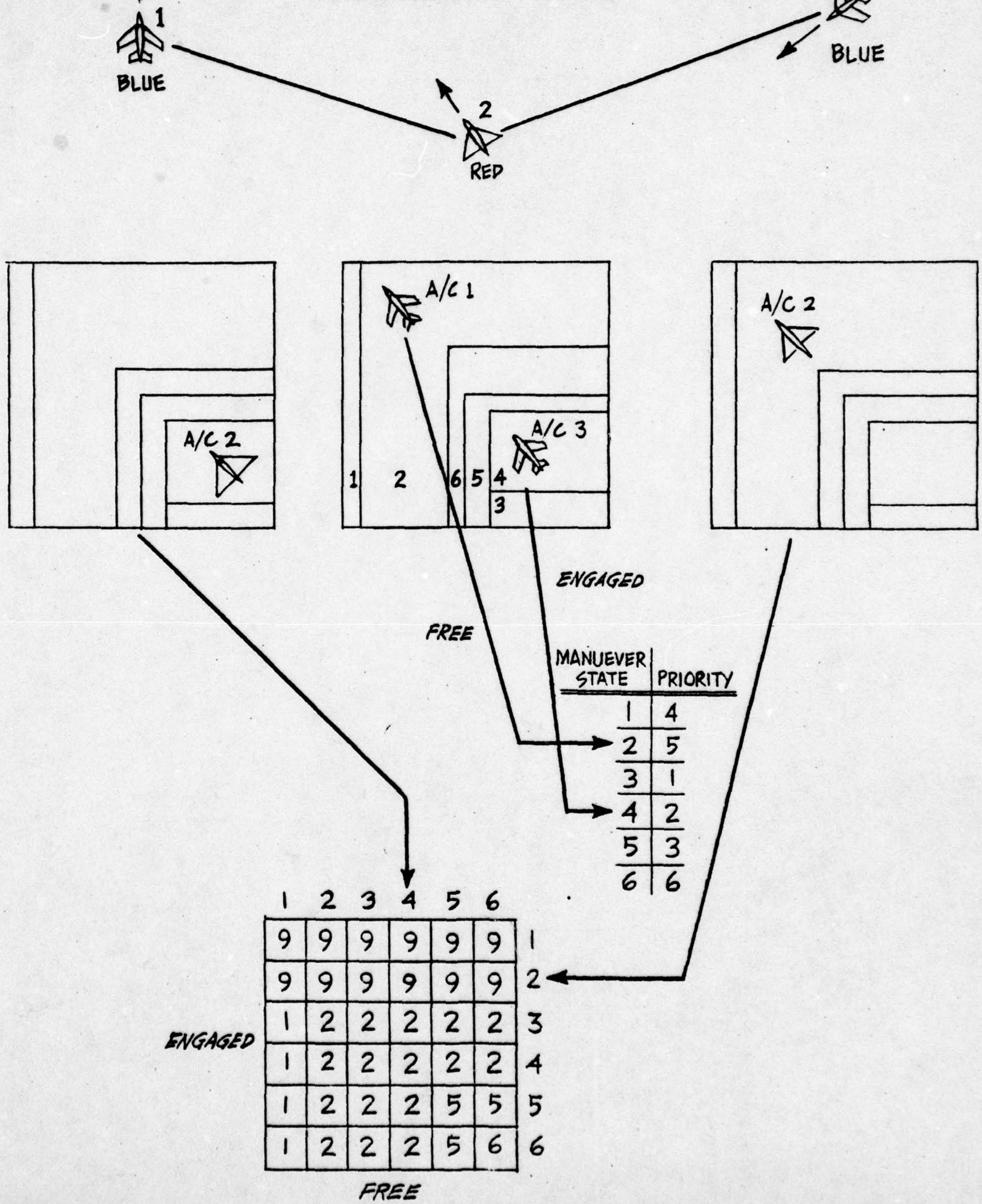
FIGURE 3-7

FREE FIGHTER ACTION TABLE

ENGAGED POSTURES ↓ / FREE POSTURES →	1	2	3	4	5	6
1	9	9	9	9	9	9
2	9	9	9	9	9	9
3	1	2	2	2	2	2
4	1	2	2	2	2	2
5	1	2	2	2	5	6
6	1	2	2	2	5	6

FIGURE 3-8

COMPLETE TACTICAL LOGIC FOR THREE AIRCRAFT:
INSTANTANEOUS PICTURE



3.2.2.2 DOUBLE ATTACK ACTION TABLES

For a side using Double Attack tactics, a table must be supplied which specifies the actions of both fighters based on their postures. This table must be entered on Form 3. Because there is no distinction drawn between free and engaged fighters if a side is using Double Attack tactics, the fighters are labeled "Lead Fighter" and "Wingman." There are two numbers entered for each location in the table. These entries represent the actions to be taken by the two fighters based on their joint posture, the first number representing the lead fighter; the second the wingman. An example of how the Double Attack action table might be filled in is shown below in Figure 3-9.

WINGMAN'S POSTURE

LEAD FIGHTER'S POSTURE	1	2	3	4	5	6
1	1 / 1	1 / 2	1 / 3	1 / 2	1 / 2	1 / 6
2	2 / 1	2 / 2	2 / 3	2 / 2	2 / 5	12 / 6
3	3 / 1	3 / 2	3 / 3	3 / 4	3 / 5	3 / 6
4	2 / 1	2 / 2	4 / 3	2 / 2	2 / 2	4 / 6
5	2 / 1	5 / 2	5 / 3	2 / 2	2 / 2	5 / 6
6	6 / 1	6 / 12	6 / 3	6 / 4	6 / 5	6 / 6

FIGURE 3-9

EACH FIGHTER'S ACTION BASED ON JOINT POSTURE

3.2.2.3 DEFENSE ZONE PARTITIONS FOR BOMBER DEFENSE TACTICS

For a side using bomber defense tactics, the usual partitioning of the tracking angle plot is not necessary or desirable. There are only two postures which have been defined for the bomber--namely, attempting to penetrate and attempting to defend. If opponents appear only in the offensive regions of the bomber's tracking angle plot, the bomber's posture is penetration. If there is at least one opponent in the defensive region, the bomber will attempt to defend itself. There is no distinction made between the four defensive regions or between the two offensive regions as would be the case for any aircraft not using bomber defense tactics. Thus, the user may read in for the bomber the same angular and range limits for all four defensive regions.

3.2.3 AIRCRAFT INPUTS

The inputs described here completely define all types of aircraft which can be used in the set of runs specified by the control cards. The seven forms which comprise the aircraft inputs are designated Form 4 through Form 10. Form 4 requires 17 lines of data. The first line asks for aircraft type and name. Aircraft type is a fixed point number that can be used for identification. The name can be any 20-character string. The parameters required by the second line are:

NA - number of values of the altitude argument in the succeeding tables.

NM - number of values of the mach argument in the succeeding tables.

NC - number of values of the lift coefficient argument in the succeeding tables.

INDP - indicator for whether or not this type of aircraft utilizes passive detection, 0=no, 1=yes.

The parameters read in from the third line are:

AREA - wing area. (square feet)

WTMAX - maximum combat weight. (pounds) (used only as an upper limit check)

WTMIN - minimum combat weight. (pounds) (used to determine point at which bingo fuel occurs.)

HMAX - combat ceiling. (feet)

RECT - oxygen debt recovery time. (seconds)

SIZFAC - dimensionless factor which is applied in determining the range at which the aircraft is detected. (This factor is the ratio of the presented area of the aircraft from the frontal aspect to the presented area of an F4 from the frontal aspect.)

FORM 4

AIRCRAFT DATA

FORM 04 A/C TYPE NAME DATE / /

NA NM NC INDP

AREA	WTMAX	WTMIN	HMAX	RECT	SIZFAC	CLMSF	SURANG

EIASTR	STGEE	SUSTIM	REGEE	RETIM	ALDTMX	EMDTMX	THDTMX

	RNOM	ALR	EP UP	EP DN
OPTICAL				
SEARCH RADAR				
TRACKING IFF				

	1	2	3	4	5	6	7	8	9	10	11	12	13	14
ALTITUDE MAX MACH														

	1	2	3	4	5	6	7	8	9	10	11	12	13	14
MACH NO MAX CL														

IB	RGUN	VB	DB	WB	CDB	BRST	ROF

FORM 5

AIRCRAFT THRUST--MILITARY POWER

FORM 05 TYPE SCALE FACTOR DATE / /

THRUST, MILITARY POWER POUNDS

MACH NO.

ALTITUDE	1	2	3	4	5	6	7	8	9	10	11	12	13	14
1														
2														
3														
4														
5														
6														
7														
8														
9														
10														
11														
12														
13														
14														
	1	2	3	4	5	6	7	8	9	10	11	12	13	14

FORM 6

AIRCRAFT THRUST--AFTERBURNER

FORM 016 TYPE ___ SCALE FACTOR ___ DATE __/__/__

THRUST, AFTERBURNER POUNDS

ALTITUDE	MACH NO.													
	1	2	3	4	5	6	7	8	9	10	11	12	13	14
1														
2														
3														
4														
5														
6														
7														
8														
9														
10														
11														
12														
13														
14														
	1	2	3	4	5	6	7	8	9	10	11	12	13	14

FORM 7

AIRCRAFT FUEL CONSUMPTION--MILITARY POWER

FORM 07 TYPE SCALE FACTOR DATE / /

FUEL CONSUMPTION, MIL POWER LBS/HOUR

MACH NO.

ALTITUDE	1	2	3	4	5	6	7	8	9	10	11	12	13	14
1														
2														
3														
4														
5														
6														
7														
8														
9														
10														
11														
12														
13														
14														
	1	2	3	4	5	6	7	8	9	10	11	12	13	14

FORM 8

AIRCRAFT FUEL CONSUMPTION--AFTERBURNER

FORM 018 TYPE ____ SCALE FACTOR ____ DATE __/__/__

FUEL CONSUMPTION, AFTERBURNER LBS/HOUR

MACH NO.

ALTITUDE	1	2	3	4	5	6	7	8	9	10	11	12	13	14
1														
2														
3														
4														
5														
6														
7														
8														
9														
10														
11														
12														
13														
14														
	1	2	3	4	5	6	7	8	9	10	11	12	13	14

FORM 9

AIRCRAFT DRAG COEFFICIENT

FORM 0 9 TYPE SCALE FACTOR DATE / /

DRAG COEFFICIENT

MACH NO.

LIFT COEFF.	1	2	3	4	5	6	7	8	9	10	11	12	13	14
1														
2														
3														
4														
5														
6														
7														
8														
9														
10														
11														
12														
13														
14														
	1	2	3	4	5	6	7	8	9	10	11	12	13	14

FORM 10

AIRCRAFT ANGLE OF ATTACK

FORM 10 TYPE ___ SCALE FACTOR ___ DATE __/__/__

ANGLE OF ATTACK DEGREES

MACH NO.

LIFT COEFF.	1	2	3	4	5	6	7	8	9	10	11	12	13	14
1														
2														
3														
4														
5														
6														
7														
8														
9														
10														
11														
12														
13														
14														
	1	2	3	4	5	6	7	8	9	10	11	12	13	14

CLMSF - scale factor which is applied to all values in the CLMAX table.

SURANG - defined in classified supplement.

The parameters read in from the fourth line are:

ETASTR - normal structural gee limit. (in gees and hundredths of gees: XX.XX)

STGEE - the maximum stress gees that be maintained.

SUTIM - the period of time for which STGEE can be sustained.

REGEE - the maximum gees that can be maintained to recover from pulling STGEE.

RETIM - the recovery time during which REGEE is the maximum allowed.

ALDTMX - the maximum rate of change of pitch angle. (degrees/second)

EMDTMX - the maximum rate of change of roll angle. (degrees/second)

THDTMX - the maximum rate of change of thrust. (pounds/second)

Lines 5 through 12 are the sensor inputs. For these lines the column headings have the following meanings:

RNOM - sensor range. (feet)

ALF - azimuth angle of the sensor pattern. (degrees)

EPUP - maximum elevation angle of the sensor pattern. (degrees)

EPDN - minimum elevation angle of the sensor pattern. (degrees) (usually $\leq$ 0.)

The angle ALF must be between 0 and 180 degrees. The azimuth of the sensor pattern is assumed to be symmetrical about the longitudinal axis of the aircraft. EPUP and EPDN must be less than 90° in magnitude. If EPDN is intended to be negative (as is generally the case) a minus sign must be included. Lines 5, 6, and 7 refer to the optical detection pattern. The values for ALF which are entered on the first two lines divide the pattern into three sectors, which may have differing values for R, EPUP and EPDN. The value of ALF on the third line is ignored (it is set to 180° in the program). The radar sensor pattern is handled in the same way as the optical. If bomber defense tactics have been selected, the value of ALF for tracking only is measured from the tail rather than from the nose. Lines 13 and 14 constitute a table of maximum mach number as a function of altitude. The altitude values are entered in feet. Similarly, lines 15 and 16 comprise a table of maximum lift coefficient as a function of mach number.

Line 17 contains the parameters which control the gun-firing lead pursuit course. These parameters are:

IB - 0, if zero slow-down is to be assumed for the bullet
1, if exponential slow-down is to be assumed for the bullet
2, if pure pursuit is desired.

RGUN - the range outside of which gun-firing is impractical. (feet)

VB - the initial velocity of the bullet. (feet/second)

DB - the diameter of the bullet. (inches)

WB - the weight of the bullet. (pounds)

CDB - drag coefficient of the bullet.

BRST - the maximum burst length for one firing of the gun. (seconds)

ROF - the rate of fire of the gun. (rounds/second)

Forms 5 through 10 are all tables with identical formats. The first line of each of these forms asks for a scale factor. Every entry in the table is multiplied by this factor, thus enabling the user to change the scale of the entries on the form. Other than this, these six forms are self-explanatory as to the entries and in what units they should be. On all tables the following requirements must be met.

1. All of the argument lists must be the same. This means the same NM values of mach number, the same NA values of altitude, and the same NC values of lift coefficient must be used for a single aircraft. (Different argument lists may be used for different aircraft.)

2. All table entries are integer forms (XXXXX), except attack angle which is in degrees and tenths of degrees (XX.X).

3. Scale factors are generally 1.0 except for drag coefficient. The scale factor may be used to allow for values greater than 99,999 by dividing the entire table by 10 and entering a scale factor of 10.

4. Maximum altitude is given in Form 5, line 3. Maximum mach numbers and lift coefficients are given in Form 5, lines 14 and 16 respectively. It is important that table entries exist for all arguments up to these maximum values.

3.2.4 MISSILE INPUTS

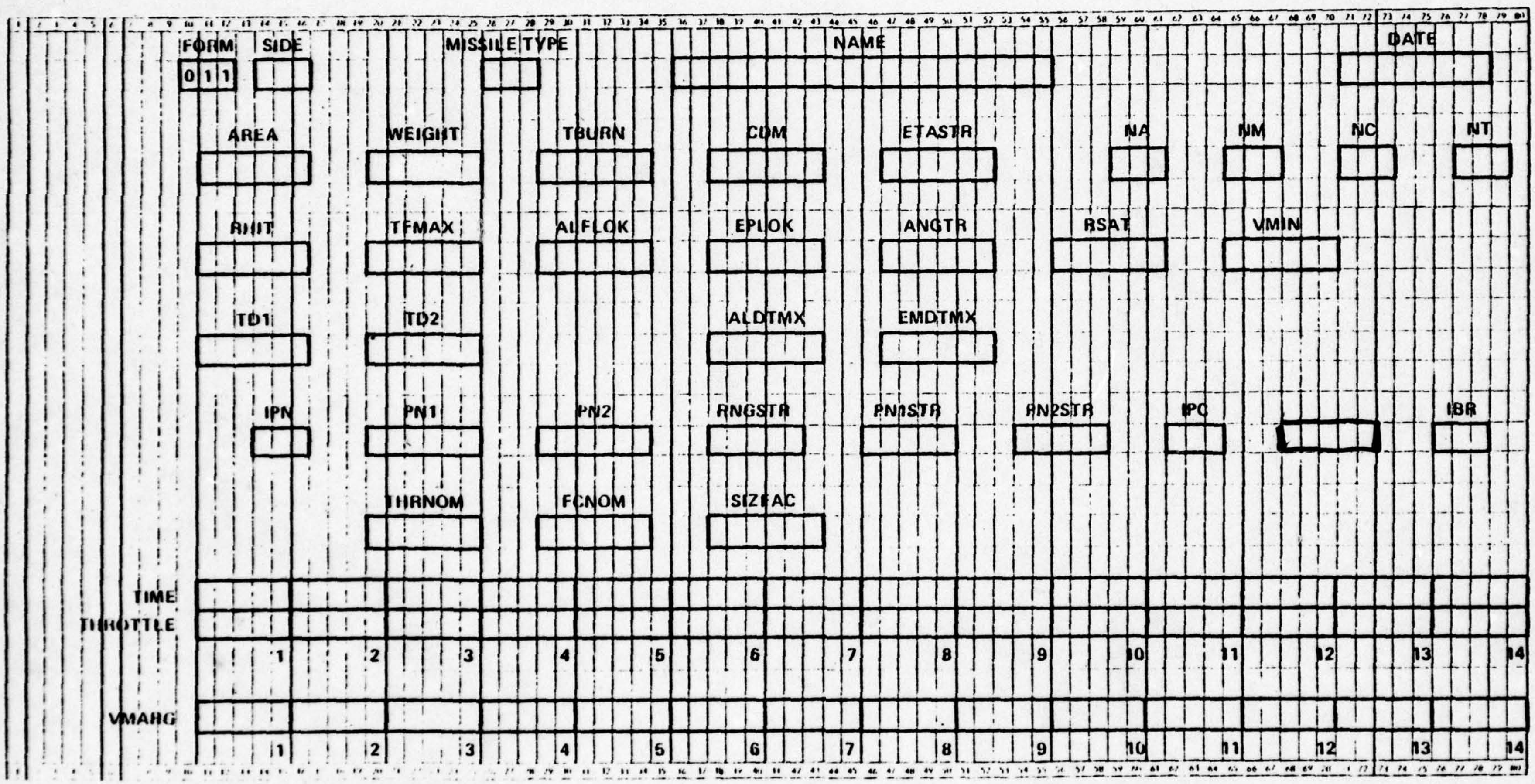
Whether or not missiles are included in the weapons complement of an aircraft in a particular set of runs, the inputs which describe the missiles' aerodynamic and guidance characteristics must be provided. These inputs are entered on Forms 11 through 14. A full set of four forms must be completed for each of four missiles -- i.e., a long-range missile and a short-range missile for each side. However, dummy inputs may be used for any or all of these missiles, as long as they are not assigned to the armament load by the inputs which specify the initial conditions of the engagement. (See Section 3.2.8)

The following parameters are called for by Form 11:

SIDE	- the side for which this missile is available (must be 1 or 2; 1=RED, 2=BLUE).
MISSILE TYPE	- identification number assigned by the user to this type of missile.
NAME	- 20 character alphanumeric name assigned by the user.
AREA	- missile cross sectional area. (square feet)
WEIGHT	- fully fueled weight of missile. (pounds)
TBURN	- time for which missile burns. (seconds)
CDM	- drag coefficient used to calculate incremental drag on the aircraft due to the mounted missile.
ETASTR	- structural gee limit for the missile.
NA	- number of altitude arguments for missile thrust, fuel consumption and maximum coefficient of lift tables.

FORM 11

MISSILE DATA



FORM 12

MISSILE MAXIMUM LIFT COEFFICIENT

FORM 12 TYPE SCALE FACTOR DATE / /

MAXIMUM LIFT COEFFICIENT, MISSILE

MACH NO.

ALTITUDE	1	2	3	4	5	6	7	8	9	10	11	12	13	14
1														
2														
3														
4														
5														
6														
7														
8														
9														
10														
11														
12														
13														
14														
	1	2	3	4	5	6	7	8	9	10	11	12	13	14

FORM 13

MISSILE DRAG COEFFICIENT

FORM 13 TYPE SCALE FACTOR DATE / /

DRAG COEFFICIENT, MISSILE

MACH NO.

LIFT COEFF.		1	2	3	4	5	6	7	8	9	10	11	12	13	14
1															
2															
3															
4															
5															
6															
7															
8															
9															
10															
11															
12															
13															
14															
		1	2	3	4	5	6	7	8	9	10	11	12	13	14

FORM 14

MISSILE ANGLE OF ATTACK

FORM 14 TYPE SCALE FACTOR DATE / /

ANGLE OF ATTACK, MISSILE DEGREES

MACH NO.

LIFT COEFF.	1	2	3	4	5	6	7	8	9	10	11	12	13	14
1														
2														
3														
4														
5														
6														
7														
8														
9														
10														
11														
12														
13														
14														
	1	2	3	4	5	6	7	8	9	10	11	12	13	14

NM	- number of mach arguments for all missile tables.
NC	- number of coefficient of lift arguments for missile coefficient of drag and angle of attack tables.
NT	- number of time arguments for missile throttle table.
RHIT	- nominal lethal radius of the missile. (feet)
TFMAX	- maximum time of flight before missile flyout is terminated. (seconds)
ALFLOK	- azimuth angle limit on missile's sensor coverage. (degrees)
EPLOK	- elevation angle limit on missile's sensor coverage. (degrees)
ANGTR	- maximum angular tracking rate for missile. (degrees/second)
RSAT	- range at which seeker saturation occurs. (feet)
VMIN	- minimum velocity for missile before quitting. (feet/second)
TD1	- time delay between missile firing and the time it is free of the fighter. (seconds)
TD2	- time delay between when missile is free of the fighter and the time of guidance enablement. (seconds)
ALDTMX	- maximum rate of change of pitch angle for the missile. (degrees/second)
EMDTMX	- maximum rate of change of roll angle for the missile. (degrees/second)
IPN	- indicator for use of proportional navigation: = 0, proportional navigation not used; = 1, proportional navigation used.
PN1	- proportional navigation constant for the desired BETA-DOT.

PN2	- proportional navigation constant for the desired GAMMA-DOT.
RNGSTR	- range between missile and target at which secondary proportional navigation constants are used.
PN1STR	- same as PN1, for the use when range is less than RNGSTR.
PN2STR	- same as PN2, for use when range is less than RNGSTR.
IPC	- indicator for use of pursuit course navigation: = 0, not required = 1, required.
THRNOM	- nominal thrust for missile. (pounds)
FCNOM	- nominal fuel consumption for missile. (pounds/hour)
SIZFAC	- dimensionless factor which is applied in determining the range at which the missile is detected. (This factor is the ratio of the presented area of the missile from the frontal aspect to the presented area of an F4 from the frontal aspect.)
TIME	- time arguments for missile throttle table.
THROTTLE	- missile throttle setting (between 0 and 1.0) as a function of time of flight.
CMARG	- mach arguments for all missile tables.

Forms 12, 13, and 14 are all tables with identical formats. The first line of each of these forms asks for a scale factor. Every entry in the table is multiplied by this factor, thus enabling the user to change the scale of the entries on the form. Other than this, these three forms are self-explanatory as to the entries and in what units they should be. On all

tables the following requirements must be met.

1. All of the argument lists must be the same. This means the same NM values of mach number, the same NA values of altitude, and the same NC values of lift coefficient must be used for a single missile. (Different argument lists may be used for different missiles.)

2. All table entries are integer forms (XXXXX), except attack angle which is in degrees and tenths of degrees (XX.X).

3. Scale factors are generally 1.0 except for drag coefficient. The scale factor may be used to allow for values greater than 99,999 by dividing the entire table by 10 and entering a scale factor of 10.

3.2.5 FIRING SCREEN INPUTS

The inputs described below completely define the conditions under which weapons firing may be accomplished dynamically within the PACAM program. Although use of the SCREEN and FIRE programs may be bypassed at the option of the user (described below), it is necessary to input a screen deck for each side, for proper operation. The input form for the SCREEN data is Form 15. If SCREEN is not to be used, only the first card must be filled out, the remaining 21 cards may be blank.

It should be remembered that while the SCREEN parameters delineate the requirements necessary for weapons release, whether or not firing actually occurs is also a function of firing policy, as input on the tactics form (Form 2).

The first card on Form 15 gives the aircraft type, or side, for which the form is applicable, the second card indicates (0=no, 1=yes) whether or not that type of weapon is mounted. If not, it is acceptable, but not necessary, to furnish data for that weapon type.

Screening parameters are of two categories, those required for weapon or fire control lock-on, and those required for firing given lock-on.

Four of the parameters on the input form refer to the

FORM 15

SCREEN INPUTS

Laser Gun

A/C TYPE		FORM 15			
WEAPONS	WPN 1	WPN 2	WPN 3	WPN 4	0 = No, 1 = Yes
	WPN 1	WPN 2	WPN 3	WPN 4	
SETOPT					= Optical Requirement (Sec)
SETTRK					= Tracking Requirement (Sec)
TRKTM					= Small Tracking Angle Requirement (Sec)
SYSTM					= System Assessment Requirement (Sec)
EPLMIS					= Lower Elevation Angle Limit (Deg)
EPUMIS					= Upper Elevation Angle Limit (Deg)
ALFLFT					= Left Side Azimuth Limit (Deg)
ALFRGT					= Right Side Azimuth Limit (Deg)
GLOLIM					= Lower Limit of Fighter Elevation Angle (Deg)
GUPLIM					= Upper Limit of Fighter Elevation Angle (Deg)
TRANG					= Small Tracking Angle (Deg)
ANGTRS					= Maximum Angular Tracking Rate (Deg/Sec)
RDOTMX					= Maximum Range Rate (Ft/Sec)
ETAMIN					= Minimum Gees for Firing
ETAMXM					= Maximum Gees for Firing
RNGMAX					= Nominal Maximum Firing Range (Ft)
RNGMIN					= Nominal Minimum Firing Range (Ft)
IFFREQ					= IFF Requirement; 0 = No, 1 = Yes
NOALOW					= Number of Weapons Allowed in Fight Simultaneously
TIMINC					= Minimum Time Between Firing (Sec)

lock-on requirement, and are defined as:

SETOPT - Time for which optical information must be available to achieve lock-on. (seconds)

SETTRK - Time for which tracking information must be available to achieve lock-on. (seconds)

TRKTM - Time for which a small tracking angle (TRANG) must be available to achieve lock-on. (seconds)

TRANG - The small tracking angle to achieve lock-on. (degrees)

After lock-on has been achieved, a number of geometric constraints must be met for an assessment period, as follows:

SYSTM - Time period for which the following constraints must be satisfied, prior to firing. (seconds)

EPLMIS - Lower limit on the elevation angle fo the LOS in aircraft body coordinates. (degrees)

EPUMIS - Upper limit on the elevation angle of the LOS in aircraft body coordinates. (degrees)

ALFLFT - Left side limit on the azimuth angle of the LOS in aircraft body coordinates. (degrees)

ALFRGT - Right side limit on the azimuth angle of the LOS in aircraft body coordinates. (degrees)

ANGTRS - Maximum angular tracking rate allowable. (degrees/second)

RDOTMT - Maximum range rate at which firing can be initiated. (feet/second)

RNGMAX - Nominal maximum range at which firing can be initiated. (feet)

RNGMIN - Nominal minimum range at which firing can be initiated. (feet)

These are also restrictions on the launching aircraft which may prevent a firing. These are:

GLOLIM - lower limit on the elevation angle of the fighter velocity vector. (degrees)

GUPLIM - upper limit on the elevation angle of the fighter velocity vector. (degrees)

ETAMIN - minimum gee loading on the fighter for firing.

ETAMXM - maximum gee loading on the fighter for firing.

Finally, these are three other screening parameters:

IFFREQ - requirement for firing; 0=no, 1=yes.

NOALOW - number of missiles of each type allowed in flight simultaneously.

TIMINC - minimum time between firings for a particular weapon type. (seconds)

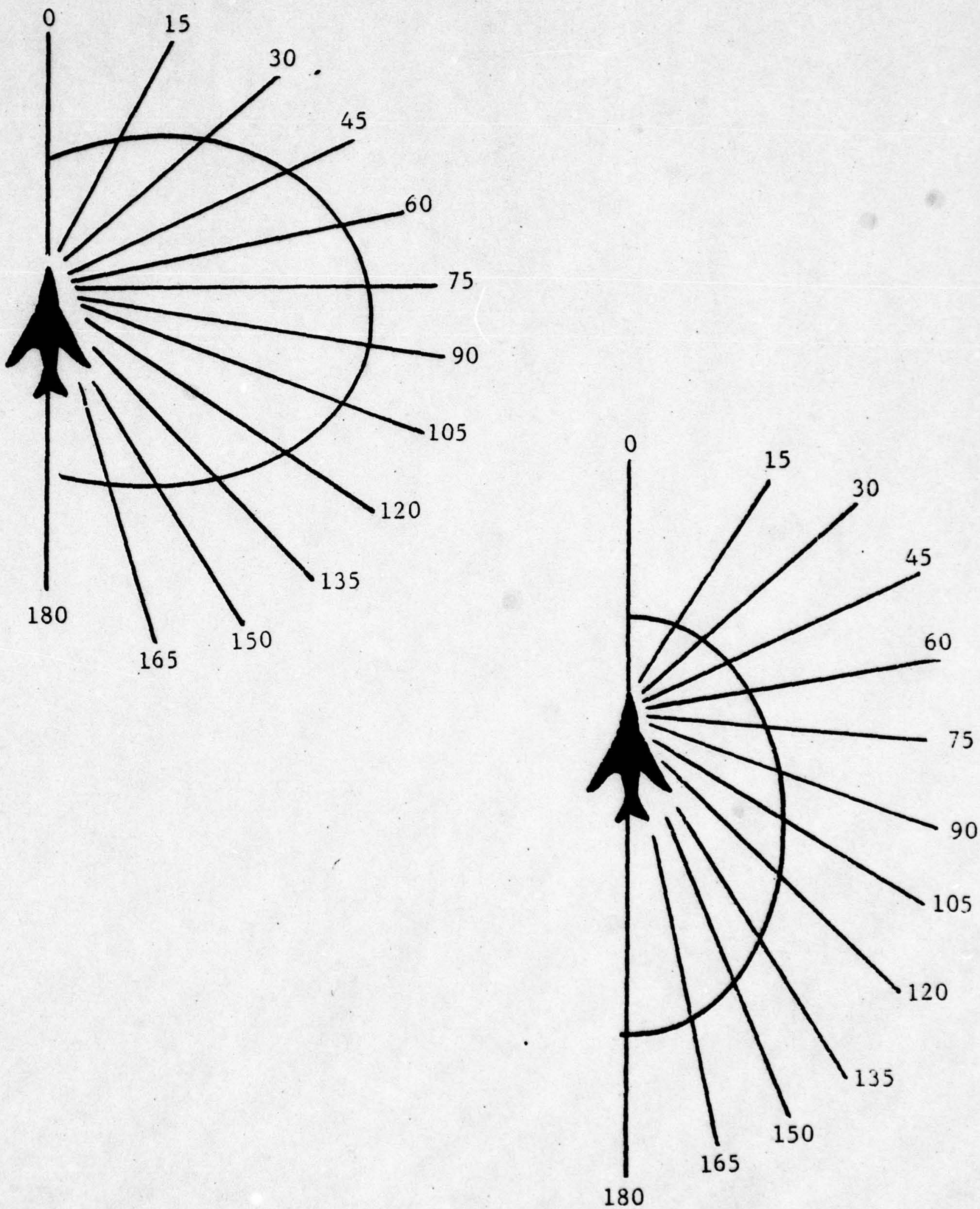
3.2.6 DETECTION CONTOURS

The effects of target aspect, sensor characteristics and countermeasures are partially accounted for in PACAM IV by means of a set of detection contours supplied by the user. Figure 3-10 gives examples of two such contours. Internally, a nominal detection range is adjusted by an interpolated value from the appropriate contour. Form 16 is used to input contour values for up to fifteen combinations of target, sensor, countermeasure characteristics. As presently coded, contour 1 is used for optical sighting, contour 2 is used for radar and contour 3 is used for tracking.

The first card on the form required a value for the number of contours (NCT) to follow. There must follow a card for each contour containing for the ratio of detection range at the indicated azimuth to that at the nose. (This assumes, of course, that the input detection range is based on a head-on target. Any other convention, consistently used, is satisfactory.) The column on the form labeled "CONTOUR ID" is for information only, at present.

FIGURE 3-10

DETECTION CONTOURS



FORM 16

DETECTION CONTOURS

FORM 16

NCT DETECTION CONTOURS

ANGLE OFF NOSE, DEGREES

CONTOUR ID	0.	15.	30.	45.	60.	75.	90.	105.	120.	135.	150.	165.	180.
	1	2	3	4	5	6	7	8	9	10	11	12	13
1													
2													
3													
4													
5													
6													
7													
8													
9													
10													
11													
12													
13													
14													
	1	2	3	4	5	6	7	8	9	10	11	12	13

3.2.7 LASER INPUTS

The laser inputs (as entered on Form 17) have been designed to conform to a program written by personnel of the LEAPS office at Kirtland Air Force Base.

As presently programmed each aircraft in the combat may use a laser weapon, but all will have the same characteristics.

The first card on Form 17 lists eight required inputs, defined below. Dimensions for the parameters appear in a classified supplement.

POL - laser power.

JITTER - twice standard deviation of 2 axis jitter.

DO - diameter of aperture.

DI - diameter of obscuration.

DR - diameter of relay mirror.

ARYA - area of spot perpendicular to beam at the target over which the intensity average is taken.

LAMBDA - laser wave length.

TSL - shot length allowed per target.

FORM 17

LASER INPUTS

FORM 17	LASER INPUT DATA							
	POL	JITTER	DO	DI	DR	ARYA	LAMBDA	TSL
	KCL							
	1	2	3	4	5			
ABBL								
MINABL								
FREQD								
ADDFLU								

The next four parameters are entered as an array, categorized by target class (KCL). The five target kill classes are listed in the classified supplement.

ABBL - intensity required to open fire.

MINABL - minimum intensity required to begin fluence accumulation.

FREQD - fluence required to burn through the target.

ADDFLU - fluence required in addition to FREQD, to negate target.

3.2.8 INITIAL CONDITION INPUTS

The input form for the initial condition cards is Form 18. This form is divided into groups of four cards which are intended to represent separate engagements. Thus, if the value of NAC on Form 2 is 2 or 3, the third and/or fourth line of each group will be left blank, and nothing need be keypunched for these lines. The concept can be generalized to more than four aircraft, as is shown in Figure 3-11. An explanation of the column headings on Form 18 follows.

NUMBER - this is an arbitrary number or character string which can be used to identify an engagement.

A/C NO. - this number identifies each aircraft in an engagement. Permitted values are 1, 2, 3 and 4.

SIDE - this must be a letter, either R or B, and is used to identify to which of the two sides (Red or Blue) the aircraft is assigned.

WEIGHT - the initial weight of the aircraft. This must lie between the values of WTMAX and WTMIN which were read from Form 4 for this aircraft type. (pounds)

ALTITUDE - the initial altitude of the aircraft. This must be less than the value of HMAX from Form 4 for this aircraft type. (feet)

VELOCITY - the initial velocity of the aircraft. This velocity must not exceed the maximum allowable mach number at the initial altitude, as calculated from the table on Form 4 for this aircraft. (feet/second)

NSHOTS - LRM (Long-Range Missile) - number of missiles.
SRM (Short-Range Missile) - number of missiles.
LASER - number of seconds of laser fuel.
GUN - number of rounds.

FORM 18

INITIAL CONDITIONS

FORM 18 INITIAL CONDITIONS PACAM IV

RUN NO	AC NO	SIDE	WEIGHT	VELOCITY	ALTITUDE	NSHOTS LRM	NSHOTS SRM	NSHOTS LASER	NSHOTS GUN	IREF	RANGE	AZREF	AZI
	01												
	02												
	03												
	04												
	01												
	02												
	03												
	04												
	01												
	02												
	03												
	04												
	01												
	02												
	03												
	04												
	01												
	02												
	03												
	04												

*IREF - the number of that aircraft to which the position of this aircraft is referenced. (Always = 1 for one-versus-one.)

*RANGE - the initial range between this aircraft and the referenced aircraft. (feet) (Note that this must be greater than the difference in altitude.)

*AZREF - the initial azimuth of this aircraft as seen by the reference aircraft (degrees). (See Figure 3-11)

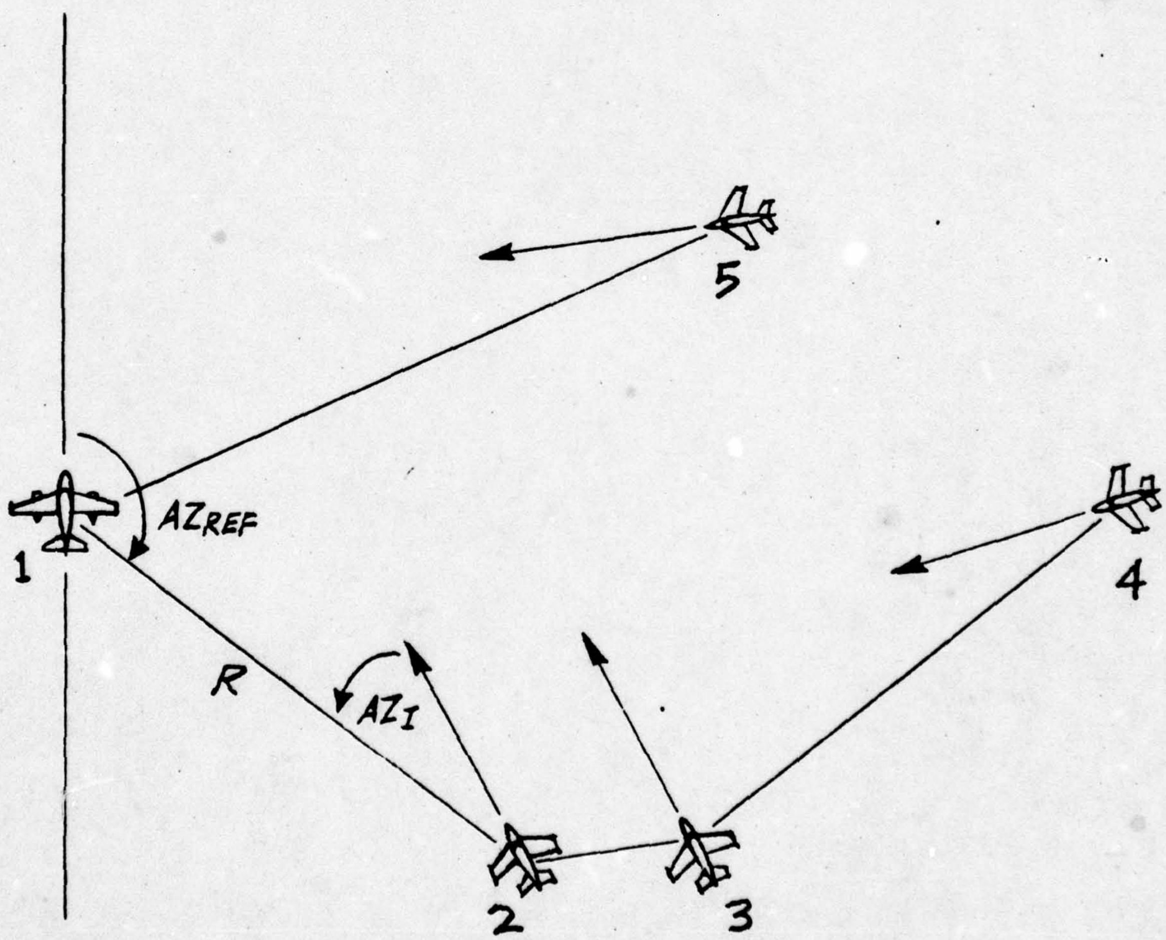
*AZI - the initial azimuth of the reference aircraft as seen by this aircraft. (degrees) (See Figure 3-11)

*The user should note that the columns for IREF, RANGE, AZREF, and AZI are omitted for the first line in each engagement. This is because the aircraft represented by this card is arbitrarily placed at the origin of the inertial coordinate system traveling in the positive X-direction, and thus, need not be referenced to any other aircraft.

FIGURE 3-11

INITIAL CONDITIONS FOR MORE THAN TWO AIRCRAFT

	SIDE	TYPE	REF	R	AZ_{REF}	AZ_I
1	1	1	—	—	—	—
2	2	2	1	7K	-135	20
3	2	2	2	100	-120	60
4	1	1	3	9K	-80	30
5	2	2	1	16K	-60	20



SECTION 4

PACAM IV OUTPUTS

4.1 INTRODUCTION

A wide variety of output options are available following the exercise of the PACAM IV program, including hard-copy reports, magnetic tape for possible input into other systems, and a series of graphic displays. These outputs are written to the local files named in Table 4-1. This section is devoted to a description of these output options and their interpretation.

Table 4-1

Type of Output	Local File	Report
Reflected Inputs	OUTPUT	4.2
Standard Aircraft Report	OUTPUT	4.3.1,4.3.2
Firing Screen Output	TAPE4	4.3.3
Special Reports	TAPE7	4.3.4
Narrative Output	TAPE9	4.3.6
B Tape	TAPE12	4.3.5
Paced Tape	TAPE13	4.3.5

4.2 REFLECTED INPUTS

As a part of the procedure for reading in data discussed in Section 3, the PACAM IV program prints out almost all of the input data at the start of each run set for run identification and error checking. The single exception is that of laser input data (Form 17) which is normally of a security classification higher than that of the other numbers.

The input data displayed here has had the benefits of some editing, round-off, reformatting and possibly some change in sequence. However, the user will have no difficulty in unambiguously correlating this printout with his completed input forms. Examples of this printout of data reflected form the input forms follow as Figures 4-1 through 4-10. Only one aircraft form, one missile form and one screen form are shown, although the program prints out all, as entered.

FIGURE 4-1
REFLECTED INPUTS
CONTROL CARDS AND TACTICAL PARAMETERS

```
              PACAM4 TEST BOMBER          NAC=    2 NTYPE=    2 NFUNS=    1 INDMC=    1 INDPCI=    1

      TMAX=       100. DLT1=      1.000 DLT2=       .100


                      SIDE 1                                   SIDE 2
              NO. TACTICS ISTURN IHOLD                 NO. TACTICS ISTURN IHOLD

               1     SN        1      1                 1     8D       1      1


                           PRIOR   RLIM   TAU1   TAU2     PRIOR   RLIM    TAU1   TAU2

             OFFENSE 1       3                              3
             OFFENSE 2       4                              4
             DEFENSE 1   3   1     3000.  135.    10.       1    30000.    90.    90.
             DEFENSE 2   4   2     9000.  120.    45.       2    30000.    90.    90.
             DEFENSE 3   5   5    18000.  135.    30.       5    30000.    90.    90.
             DEFENSE 4   6   6    30000.  135.    30.       6    30000.    90.    90.


   ESC    ESC   OVER    MAX -FORMATION-         ESC    ESC   OVER    MAX -FORMATION-
   ALT   MACH   TAKE    LAG     X      Y        ALT   MACH   TAKE    LAG     X      Y
36000.   1.15   169.    30.   300.   954.     36000.  1.15     0.    30.   300.   954.

     ----------PENETRATION POINT 1---------------------PENETRATION POINT 2-----------
              X          Y           Z        SPEED              X          Y          Z        SPEED
         10000.     10000.        100.        800.          50000.     50000.       100.        801.


                             FREE                                    FREE
                            FIGHTER                                 FIGHTER
                          1 2 3 4 5 6                             1 2 3 4 5 6

                       1  9 9 9 9 9 9                          1  9 9 9 9 9 9
                       2  9 9 9 9 9 9                          2  9 9 9 9 9 9
             ENGAGED   3  1 2 2 2 2 2               ENGAGED    3  1 2 2 2 2 2
             FIGHTER   4  1 2 2 2 2 2               FIGHTER    4  1 2 2 2 2 2
                       5  1 2 3 4 6 6                          5  1 2 3 4 [illegible] 6
                       6  1 2 3 4 5 5                          6  1 2 3 4 [illegible] 5

                                       DOUBLE ATTACK
                                         MANEUVERS

          1      2      3      4      5      6                   1      2      3      4      5      6

    1   0- 0   0- 0   0- 0   0- 0   0- 0   0- 0            1   0- 0   0- 0   0- 0   0- 0   0- 0   0- 0
    2   0- 0   0- 0   0- 0   0- 0   0- 0   0- 0            2   0- 0   0- 0   0- 0   0- 0   0- 0   0- 0
    3   0- 0   0- 0   0- 0   0- 0   0- 0   0- 0            3   0- 0   0- 0   0- 0   0- 0   0- 0   0- 0
    4   0- 0   0- 0   0- 0   0- 0   0- 0   0- 0            4   0- 0   0- 0   0- 0   0- 0   0- 0   0- 0
    5   0- 0   0- 0   0- 0   0- 0   0- 0   0- 0            5   0- 0   0- 0   0- 0   0- 0   0- 0   0- 0
    6   0- 0   0- 0   0- 0   0- 0   0- 0   0- 0            6   0- 0   0- 0   0- 0   0- 0   0- 0   0- 0
```

FIGURE 4-2

REFLECTED INPUTS

GENERAL AIRCRAFT INFORMATION

```
      1 A/C NO 6

NA =   14  NM =   14  NC =   14  INDPV = 0
AREA =   280.00  MAX WT = 23100.00  MIN WT = 17167.00  MAX HT = 65000.00  RECT =     5.00  SIZFAC =     1.00  CLMSF =     1.00

FIASTR =  7.33 STGFF =  9.33 SUTIM =  2.00 REGFF=  4.00 RETIM =  5.00 ALDTMX =180.00 FMDTMX =180.00 THDTMX =10000.

                      R    ALF  FP-UP FP-DN
      OPTICAL  36000.   40.   30.  -15.
               36000.  120.   30.  -40.
                1000.  180.   90.    0.
      RADAR   159000.   60.   60.  -60.
                   0.   60.   60.  -60.
                   0.  180.   60.  -60.
     TRACKING  30000.   60.   60.  -60.
       IFF         0.   60.   15.  -15.

ALTITUDE     0.  5000. 10000. 15000. 20000. 25000. 30000. 36089. 40000. 45000. 50000. 55000. 60000. 65000.
MAX MACH   1.20   1.30   1.42   1.55   1.69   1.86   2.00   2.00   2.00   2.00   2.00   2.00   2.00   2.00

 MACH NO   0.00    .20    .40    .60    .80    .90   1.00   1.10   1.20   1.30   1.40   1.60   1.80   2.00
  MAX CL  1.600  1.600  1.600  1.600  1.600  1.600  1.600  1.600  1.577  1.225  1.036   .832   .720   .640

      TRTYPE =  1    RGUN =  2000.   VB =  3500.   DB =    .80   WB =    .21   CDB =   .160
```

FIGURE 4-3

REFLECTED INPUTS

AIRCRAFT THRUST TABLES

THRUST,MILITARY POWER POUNDS

MACH

ALTITUDE	0.00	.20	.40	.60	.80	.90	1.00	1.10	1.20	1.30	1.40	1.60	1.80	2.00
	1	2	3	4	5	6	7	8	9	10	11	12	13	14
0.	11982.	12230.	12153.	12641.	12386.	12163.	11697.	11980.	10903.	9079.	0.	0.	0.	0.
5000.	10200.	10295.	10713.	11176.	11291.	11090.	10788.	10321.	10199.	9959.	9609.	0.	0.	0.
10000.	8900.	8925.	9042.	9824.	10182.	10121.	9857.	9509.	9444.	9326.	9187.	7853.	0.	0.
15000.	7400.	7489.	7727.	8383.	8932.	9062.	9007.	8698.	8707.	8631.	8598.	7707.	6347.	0.
20000.	6100.	6126.	6379.	7062.	7763.	7946.	8041.	7950.	7935.	7939.	7916.	7329.	6337.	0.
25000.	4900.	4913.	5133.	5773.	6516.	6880.	7649.	7063.	7248.	7196.	7279.	6877.	6216.	5456.
30000.	3900.	3910.	4081.	4590.	5270.	5669.	6061.	6191.	6405.	6541.	6510.	6261.	5853.	5308.
36089.	2900.	2913.	3044.	3419.	3920.	4258.	4656.	5041.	5394.	5542.	5720.	5522.	5318.	4960.
40000.	2500.	2500.	2517.	2830.	3239.	3515.	3846.	4169.	4382.	4491.	4608.	4446.	4302.	4011.
45000.	1900.	1900.	1925.	2187.	2523.	2740.	2997.	3191.	3333.	3430.	3483.	3377.	3257.	2993.
50000.	1400.	1400.	1491.	1650.	1925.	2101.	2314.	2415.	2513.	2595.	2612.	2531.	2361.	2213.
55000.	1400.	1400.	1400.	1400.	1458.	1585.	1739.	1798.	1883.	1925.	1925.	1878.	1700.	1596.
60000.	1000.	1000.	1000.	1000.	1176.	1239.	1297.	1325.	1388.	1405.	1405.	1359.	1199.	1044.
65000.	900.	900.	900.	900.	900.	900.	933.	947.	984.	1004.	1004.	947.	779.	659.

THRUST AFTERBURNER POUNDS

MACH

ALTITUDE	0.00	.20	.40	.60	.80	.90	1.00	1.10	1.20	1.30	1.40	1.60	1.80	2.00
	1	2	3	4	5	6	7	8	9	10	11	12	13	14
0.	19189.	20613.	21794.	24731.	26054.	27367.	28853.	30377.	32194.	31496.	0.	0.	0.	0.
5000.	17400.	17435.	19218.	21461.	23531.	24641.	26015.	27266.	28986.	30636.	32110.	0.	0.	0.
10000.	15200.	15259.	16327.	18886.	21083.	22143.	23306.	24533.	25925.	27422.	28988.	29985.	0.	0.
15000.	12900.	12998.	14079.	16155.	18395.	19641.	20829.	21832.	23130.	24387.	25831.	27077.	27582.	0.
20000.	10800.	10872.	11943.	13725.	15964.	17061.	18314.	19378.	20445.	21607.	22805.	24157.	24797.	0.
25000.	8800.	8802.	9700.	11454.	13463.	14680.	15837.	16893.	18028.	18935.	20041.	21391.	22119.	22715.
30000.	7000.	7055.	7781.	9246.	11100.	12237.	13489.	14504.	15580.	16594.	17453.	18655.	19505.	20060.
36089.	5200.	5292.	5865.	6977.	8437.	9385.	10537.	11687.	12803.	13670.	14674.	15662.	16539.	17043.
40000.	4700.	4700.	4750.	5684.	6853.	7647.	8642.	9656.	10433.	11159.	11917.	12721.	13504.	13894.
45000.	3500.	3500.	3560.	4307.	5251.	5880.	6630.	7331.	7930.	8573.	9098.	9761.	10371.	10634.
50000.	2600.	2600.	2688.	3185.	3945.	4456.	5061.	5542.	6011.	6480.	6846.	7373.	7689.	8076.
55000.	2000.	2000.	2064.	2443.	2922.	3296.	3772.	4129.	4505.	4814.	5109.	5507.	5688.	5994.
60000.	1500.	1500.	1594.	1841.	2244.	2499.	2791.	3034.	3302.	3511.	3753.	4027.	4139.	4245.
65000.	1200.	1200.	1203.	1409.	1617.	1750.	1927.	2115.	2308.	2485.	2705.	2870.	2884.	2962.

FIGURE 4-4

REFLECTED INPUTS

AIRCRAFT FUEL CONSUMPTION TABLES

FUEL CONSUMPTION MILITARY POWER LBS/HOUR

MACH

ALTITUDE	0.00 (1)	.20 (2)	.40 (3)	.60 (4)	.80 (5)	.90 (6)	1.00 (7)	1.10 (8)	1.20 (9)	1.30 (10)	1.40 (11)	1.60 (12)	1.80 (13)	2.00 (14)
0.	9214.	10000.	10702.	11836.	12650.	13251.	13945.	14707.	15595.	15101.	0.	0.	0.	0.
5000.	8400.	8414.	9365.	10359.	11295.	11763.	12366.	13039.	13809.	14542.	15218.	0.	0.	0.
10000.	7140.	7149.	7849.	9022.	9994.	10462.	10935.	11509.	12170.	12804.	13471.	14077.	0.	0.
15000.	5900.	5910.	6581.	7635.	8663.	9178.	9686.	10129.	10696.	11227.	11818.	12418.	12734.	0.
20000.	4700.	4776.	5357.	6323.	7463.	7934.	8424.	8935.	9363.	9815.	10301.	10881.	11172.	0.
25000.	3700.	3771.	4248.	5093.	6179.	6796.	7246.	7699.	8218.	8538.	8951.	9471.	9774.	9900.
30000.	2900.	2955.	3324.	3982.	4913.	5515.	6145.	6591.	7026.	7445.	7740.	8165.	8471.	8584.
36089.	2100.	2160.	2434.	2911.	3580.	4052.	4620.	5259.	5735.	6076.	6482.	6774.	7049.	7156.
40000.	2000.	2000.	2046.	2447.	3001.	3392.	3869.	4391.	4706.	4971.	5278.	5535.	5779.	5869.
45000.	1500.	1500.	1597.	1921.	2372.	2694.	3061.	3406.	3640.	3851.	4051.	4277.	4472.	4528.
50000.	1200.	1200.	1270.	1485.	1842.	2091.	2400.	2625.	2797.	2971.	3110.	3297.	3414.	3492.
55000.	1400.	1400.	1400.	1400.	1431.	1615.	1832.	1995.	2143.	2261.	2398.	2531.	2603.	2677.
60000.	1100.	1100.	1100.	1100.	1182.	1283.	1397.	1508.	1624.	1701.	1814.	1919.	1971.	2002.
65000.	1000.	1000.	1000.	1000.	1000.	1000.	1040.	1119.	1203.	1277.	1358.	1438.	1459.	1487.

FUEL CONSUMPTION, AFTERBURNER LBS/HOUR

MACH

ALTITUDE	0.00 (1)	.20 (2)	.40 (3)	.60 (4)	.80 (5)	.90 (6)	1.00 (7)	1.10 (8)	1.20 (9)	1.30 (10)	1.40 (11)	1.60 (12)	1.80 (13)	2.00 (14)
0.	44000.	46000.	53900.	59000.	65621.	77047.	78539.	80096.	88744.	91839.	0.	0.	0.	0.
5000.	38000.	40961.	45540.	51415.	57718.	61331.	65638.	70567.	76170.	81846.	87483.	0.	0.	0.
10000.	32000.	35197.	39353.	44052.	50140.	53231.	56812.	60984.	65805.	70897.	76184.	84006.	0.	0.
15000.	27000.	29725.	32599.	37302.	42493.	45866.	49196.	52477.	56589.	60708.	65427.	72337.	79317.	0.
20000.	23000.	25119.	27390.	31337.	36406.	38827.	41951.	45305.	49473.	51898.	55680.	61777.	67407.	0.
25000.	18000.	20535.	22672.	26133.	30493.	33128.	35577.	38304.	41600.	44167.	47409.	52441.	58948.	62212.
30000.	15000.	16677.	18405.	21296.	24966.	27540.	30086.	32279.	34917.	37756.	40087.	44243.	48189.	51949.
36089.	12000.	12721.	14061.	16302.	19147.	21032.	23249.	25948.	29122.	30033.	32735.	35848.	39059.	41729.
40000.	10000.	10090.	11556.	13465.	15827.	17398.	19222.	21439.	23142.	24664.	26571.	29326.	32179.	34347.
45000.	8000.	8000.	8888.	10406.	12349.	13619.	15073.	16600.	17889.	19142.	20491.	22653.	24974.	26588.
50000.	6000.	6000.	6899.	7936.	9486.	10510.	11713.	12810.	13771.	14795.	15652.	17490.	18983.	20527.
55000.	5000.	5000.	5499.	6279.	7251.	8011.	8927.	9680.	10512.	11231.	11940.	13353.	14424.	15735.
60000.	4000.	4000.	4334.	4974.	5780.	6261.	6792.	7324.	7909.	8431.	9048.	10037.	10865.	11647.
65000.	3000.	3000.	3301.	3802.	4325.	4673.	5036.	5424.	5845.	6251.	6762.	7445.	7976.	8575.

FIGURE 4-5

REFLECTED INPUTS

AIRCRAFT DRAG COEFFICIENT AND ANGLE OF ATTACK TABLES

DRAG COEFFICIENT
MACH

	0.00	.20	.40	.60	.80	.90	1.00	1.10	1.20	1.31	1.40	1.60	1.80	2.00
LIFT COFF	1	2	3	4	5	6	7	8	9	10	11	12	13	14
0.00	.03	.03	.02	.02	.02	.03	.04	.05	.05	.15	.05	.05	.05	.05
.20	[illegible]	.03	.03	.03	.03	.03	.05	.06	.06	.16	.06	.06	.07	.07
.30	.04	.03	.03	.03	.03	.04	.05	.06	.07	.07	.07	.08	.08	.09
[illegible]	.05	.04	.04	.04	.04	.04	.06	.07	.08	.08	.09	.10	.10	.11
[illegible]	.06	.06	.05	.05	.05	.05	.08	.09	.10	.10	.11	.12	.13	.15
[illegible]	.08	.07	.07	.07	.07	.07	.09	.11	.12	.13	.14	.16	.17	.19
[illegible]	.10	.09	.09	.08	.08	.09	.11	.13	.15	.16	.17	.20	.22	.25
[illegible]	.12	.12	.11	.11	.11	.12	.15	.17	.19	.20	.22	.25	.27	0.00
.90	.15	.14	.14	.14	.14	.15	.19	.21	.22	[illegible]	.27	.32	0.00	0.00
1.00	.19	.18	.17	.19	.19	.20	.23	.25	.27	[illegible]	.32	0.00	0.00	0.00
1.20	.31	.29	.27	.27	.29	.31	.34	.37	.40	[illegible]	.45	0.00	0.00	0.00
1.40	.62	.52	.46	.42	.45	.47	.50	.54	.58	[illegible]	0.00	0.00	0.00	0.00
1.60	.79	.73	.67	.63	.65	.69	.74	.80	.86	[illegible]	0.00	0.00	0.00	0.00
1.80	1.00	.92	.84	.79	.82	.87	.93	.99	1.08	[illegible]	0.00	0.00	0.00	0.00

ANGLE OF ATTACK
MACH

	0.00	.20	.40	.60	.80	.90	1.00	1.10	1.20	1.31	1.40	1.60	1.80	2.00
LIFT COFF	1	2	3	4	5	6	7	8	9	10	11	12	13	14
0.00	.48	.50	.63	.70	.53	.48	.75	1.05	1.07	[illegible]	1.14	1.38	1.50	1.52
.20	2.60	2.60	2.63	2.72	2.39	2.07	2.39	2.77	3.02	[illegible]	3.50	4.10	4.61	5.10
.30	4.15	4.17	4.15	4.05	3.60	3.17	3.47	3.93	4.32	[illegible]	5.07	5.92	6.75	7.07
.40	5.50	5.50	5.45	5.37	4.76	4.27	4.52	5.16	5.62	[illegible]	6.60	7.80	8.85	9.85
.50	6.88	6.85	6.78	6.65	5.90	5.38	5.60	6.34	6.95	[illegible]	8.21	9.72	11.15	12.35
.60	8.45	8.35	8.19	7.79	7.03	6.48	6.70	7.50	8.26	[illegible]	9.80	11.77	13.55	15.15
.70	9.90	9.78	9.52	8.99	8.26	7.72	7.74	8.67	9.60	[illegible]	11.50	13.90	15.82	17.50
.80	11.35	11.28	11.07	10.50	9.60	9.13	8.90	9.95	10.99	12.10	13.33	15.78	18.10	0.00
.90	12.85	12.78	12.63	12.25	11.39	10.80	10.20	11.25	12.65	[illegible]	15.30	17.70	0.00	0.00
1.00	14.41	14.35	14.20	13.90	13.38	12.73	11.60	12.78	14.45	[illegible]	17.35	0.00	0.00	0.00
1.20	17.67	17.62	17.65	17.45	17.17	16.72	15.05	16.25	18.60	[illegible]	19.35	0.00	0.00	0.00
1.40	22.80	21.95	21.75	21.33	21.00	20.68	19.65	20.60	23.70	[illegible]	0.00	0.00	0.00	0.00
1.60	28.80	28.62	27.60	25.25	24.95	25.50	25.52	26.80	31.00	[illegible]	0.00	0.00	0.00	0.00
1.80	36.00	35.00	33.40	29.10	28.70	30.00	31.50	31.00	38.58	[illegible]	0.00	0.00	0.00	0.00

FIGURE 4-6

REFLECTED INPUTS

GENERAL MISSILE INFORMATION

PARAMETERS FOR MISSILE WHOSE NAME IS SIDEWINDER TEST

SIDE NO. 1, TYPE NO. 1

AREA = .5000	HTMAX = 500.0	TBURN = 7.0	CCM = .05	FTASTP = 24.00
PHIT = 400.0	TFMAX = 15.0	ALFLOK = 60.0	FPLOK = 60.0	ANGIR = 140.0
RSAT = 2000.0	VMIN = 400.0	TR1 = .30	TR2 = .40	ALDTMX = 30.00
EMDTMX = 90.00	IPN = 1	PN1 = 2.828	PN2 = 2.828	RNGSTP = 3000.0
PN1STP = 5.600	PN2STP = 5.600	IPC = 0	XLAGMX = 15.00	IGUIDE = 0
THRNOM = 7000.0	FCNOM =102457.			

THROTTLE SETTING

TIME	0.00	1.00	2.00	3.00	4.00	5.00	6.00	7.00	8.00
THROTTLE	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.00

MAXIMUM LIFT COEFFICIENT

MACH NUMBER

ALTITUDE	0.00	.50	.75	1.05	1.10	1.30	1.70	2.00	2.30	2.60	3.00	3.10	15.00
0.	12.280	11.480	10.340	11.640	11.160	6.710	4.350	3.000	2.120	1.640	1.240	1.060	.960
10000.	12.280	11.480	10.340	11.640	11.160	10.020	6.300	4.330	3.080	2.510	1.830	1.340	1.340
20000.	12.280	11.480	10.340	11.640	11.160	10.020	8.160	5.090	4.510	3.560	2.690	1.830	1.830
30000.	12.280	11.480	10.340	11.640	11.160	10.020	8.160	7.020	6.160	4.770	3.540	3.160	2.700
40000.	12.280	11.480	10.340	11.640	11.160	10.020	8.160	7.020	6.160	5.500	5.030	4.940	3.810
90000.	12.280	11.480	10.340	11.640	11.160	10.020	8.160	7.020	6.160	5.500	5.030	4.940	3.990

FIGURE 4-7

REFLECTED INPUTS

MISSILE DRAG COEFFICIENT AND ANGLE OF ATTACK TABLES

MISSILE DRAG COEFFICIENT

MACH NUMBER

LIFT COEF	0.00	.50	.75	1.05	1.10	1.30	1.70	2.00	2.30	2.60	3.00	3.10	15.00
0.000	1.050	1.100	1.250	1.900	2.000	1.950	1.700	1.600	1.500	1.400	1.250	1.200	1.150
1.000	1.120	1.150	1.300	1.910	2.050	2.010	1.780	1.680	1.550	1.480	1.320	1.310	1.310
2.000	1.200	1.240	1.320	2.000	2.120	2.120	1.890	1.790	1.670	1.600	1.510	1.480	1.450
3.000	1.310	1.350	1.400	2.140	2.310	2.330	2.030	1.960	1.850	1.810	1.750	1.790	1.790
4.000	1.460	1.500	1.520	2.300	2.340	2.390	2.280	2.210	2.200	2.160	2.110	2.200	2.210
5.000	1.670	1.700	1.720	2.500	2.520	2.600	2.590	2.580	2.610	2.650	2.750	2.700	2.850
6.000	1.950	1.900	2.130	2.710	2.760	2.909	3.000	3.080	3.170	3.300	3.400	3.350	3.300
7.000	2.320	2.200	2.480	2.980	3.090	3.200	3.500	3.670	3.800	4.000	4.100	4.050	3.900
8.000	2.700	2.530	2.950	3.300	3.490	3.590	4.100	4.300	4.400	4.700	4.800	4.750	4.500
9.000	3.100	2.900	3.400	3.800	3.900	4.120	4.700	4.800	4.900	5.300	5.400	5.350	5.000
10.000	3.490	3.320	3.880	4.450	4.350	5.050	5.300	5.350	5.450	6.000	6.100	6.050	5.600
11.000	3.870	4.120	4.370	5.170	5.000	5.900	5.900	5.900	6.000	6.600	6.700	6.650	6.150
12.000	4.300	5.100	4.850	5.800	5.900	6.800	6.500	6.450	6.550	7.200	7.300	7.250	6.700
13.000	5.000	6.000	5.300	6.400	6.800	7.700	7.200	7.000	7.100	7.800	7.900	7.850	7.500

ANGLE OF ATTACK (DEGREES)

MACH NUMBER

LIFT COEF	0.00	.50	.75	1.05	1.10	1.30	1.70	2.00	2.30	2.60	3.00	3.10	15.00
0.000	1.95	1.60	2.10	1.00	1.20	1.25	1.05	.45	.75	.60	.70	.85	.55
1.000	2.75	2.30	2.70	1.65	1.80	1.90	1.75	1.35	1.70	1.65	1.80	1.95	2.10
2.000	3.55	2.95	3.30	2.30	2.40	2.60	2.50	2.30	2.60	2.70	2.90	3.00	3.20
3.000	4.35	3.65	3.90	2.95	3.00	3.25	3.20	3.25	3.50	3.75	4.00	4.10	4.35
4.000	5.15	4.35	4.50	3.60	3.60	3.90	4.90	4.15	4.45	4.75	5.10	5.20	5.45
5.000	5.95	5.00	5.10	4.25	4.25	4.55	4.55	5.10	5.35	5.80	6.20	6.30	6.60
6.000	6.75	5.70	5.70	4.90	4.85	5.20	5.25	6.00	6.25	6.80	7.25	7.40	7.75
7.000	7.55	6.40	6.40	5.55	5.45	5.85	5.95	6.95	7.15	7.85	8.35	8.50	8.85
8.000	8.35	7.05	7.00	6.20	6.05	6.55	6.65	7.90	8.10	8.90	9.45	9.60	10.00
9.000	9.15	7.75	7.60	6.85	6.70	7.20	7.35	8.80	9.00	9.95	10.00	10.00	10.00
10.000	9.95	8.40	8.20	7.50	7.30	7.85	8.05	9.75	9.90	10.00	10.00	10.00	10.00
11.000	10.00	9.10	8.80	8.15	7.90	8.50	8.75	10.00	10.00	10.00	10.00	10.00	10.00
12.000	10.00	9.80	9.40	8.75	8.50	9.15	9.45	10.00	10.00	10.00	10.00	10.00	10.00
13.000	10.00	10.00	10.00	9.35	9.15	9.85	10.00	10.00	10.00	10.00	10.00	10.00	10.00

FIGURE 4-8
REFLECTED INPUTS
WEAPONS SCREENING PARAMETERS

CONDITIONS TO BE SATISFIED FOR WEAPON FIRING

AIRCRAFT TYPE 1

	WEAPON 1	WEAPON 2	WEAPON 3	WEAPON 4
CONDITIONS 1-3 ARE REQUIRED FOR LOCK-ON				
1. OPTICAL REQUIREMENT (SEC)	0.00	6.00	0.00	0.00
2. TRACKING REQUIREMENT (SEC)	0.00	3.00	0.00	0.00
3. SMALL TRACKING ANGLE (DEG)	10.00	5.00	10.00	0.00
REQUIRED FOR (SEC)	0.00	3.00	0.00	0.00
CONDITIONS 4-17 REQUIRED FOR FIRING AFTER LOCK-ON				
4. SYSTEM ASSESSMENT (COND. 5-12) REQUIREMENT (SEC)	1.00	5.00	1.00	0.00
5. NOMINAL MAXIMUM RANGE LIMIT (FT)	50000.	6000.	50000.	0.
6. NOMINAL MINIMUM RANGE LIMIT (FT)	50.	500.	50.	0.
7. UPPER ELEVATION ANGLE LIMIT (DEG)	60.00	15.00	60.00	0.00
8. LOWER ELEVATION ANGLE LIMIT (DEG)	-30.00	-10.00	-30.00	0.00
9. RIGHT SIDE AZIMUTH ANGLE LIMIT (DEG)	60.00	30.00	60.00	0.00
10. LEFT SIDE AZIMUTH ANGLE LIMIT (DEG)	60.00	40.00	60.00	0.00
11. MAXIMUM ANGLE OFF RATE (DEG/SEC)	60.00	45.00	60.00	0.00
12. MAXIMUM RANGE RATE (FT/SEC)	1000.	1500.	3000.	0.
13. IFF REQUIREMENT 0=NO , 1=YES	0	0	0	0
FIGHTER CONSTRAINTS FOR FIRING				
14. UPPER LIMIT ON ELEVATION ANGLE (DEG)	70.00	50.00	70.00	0.00
15. LOWER LIMIT ON ELEVATION ANGLE (DEG)	-70.00	-60.00	-70.00	0.00
16. MAXIMUM GEE LIMIT	10.00	8.00	10.00	0.00
17. MINIMUM GEE LIMIT	0.00	0.00	0.00	0.00
NUMBER ALLOWED IN FLIGHT SIMULTANEOUSLY	5	1	1	1
MINIMUM TIME INCREMENT BETWEEN FIRINGS (SEC)	6.00	6.00	6.00	0.00

FIGURE 4-9

REFLECTED INPUT

DETECTION RANGE CONTOURS

DETECTION RANGE CONTOURS
(NORMALIZED FROM HEAD-ON ASPECT)

CONTOUR NUMBER	ASPECT ANGLE OFF NOSE (DEGREES) 0.0	15.0	30.0	45.0	60.0	75.0	90.0	105.0	120.0	135.0	150.0	165.0	180.0
1	1.000	1.180	1.430	1.900	2.330	2.500	2.530	2.550	2.600	2.750	2.930	3.150	3.630
2	1.000	1.560	2.130	2.370	2.440	2.370	2.240	2.390	2.630	2.810	3.020	3.290	3.760
3	1.000	.910	.790	.710	.660	.640	.630	.610	.590	.620	.640	.670	.710
4	1.000	.970	.940	.830	.820	.800	.770	.730	.700	.680	.670	.670	.670
5	1.000	.900	1.200	1.300	1.400	1.450	1.500	1.450	1.400	1.300	1.200	1.400	1.000
6	1.000	1.800	2.400	2.600	2.800	2.900	3.000	2.900	2.800	2.600	2.400	1.800	1.000

FIGURE 4-10

REFLECTED INPUTS

INITIAL CONDITIONS

A/C NO	SIDE	WEIGHT	VELOCITY	ALTITUDE	WPN1	WPN2	WPN3	WPN4	IREF	RANGE	AZREF	AZI
1	P	20133.	800.	100.	2.	0.	0.	0.				
2	R	480000.	600.	100.	0.	0.	10.	0.	1	15000.	-30.	150.

4.3 AIRCRAFT REPORTS

4.3.1 STANDARD AIRCRAFT REPORT

A standard report of aircraft position, orientation, maneuver state and information state is produced for each PACAM IV run and is written to the local file OUTPUT. On this report, there is one line printed for each aircraft in the engagement, at each major time pulse (DLT1). An example of one page of this report is shown in Figure 4-11. An explanation of the column headings follows.

TIME - the time in the engagement. (seconds)

A/C - the aircraft number that was input on the initial condition form.

ALT - the altitude of the aircraft. (feet)

GAM - the elevation of the aircraft's velocity vector. (degrees)

BETA - the azimuth of the aircraft's velocity vector. (degrees)

SPED - the speed of the aircraft. (knots)

MU - the roll angle of the aircraft. (degrees)

ALPH - the pitch angle of the aircraft. (degrees)

THROT - the throttle setting:
0.0 - 0.5 military power,
0.5 - 1.0 afterburner power.

GEES - the acceleration normal to the longitudinal axis of the aircraft.

TI-MS - the tracking index and maneuver state of the aircraft. The tracking index = 0, if the aircraft is not tracking; = the number of the aircraft or missile being tracked, otherwise.

The maneuver state of the aircraft is equivalent to its action. All possible

FIGURE 4-11

STANDARD PRINTED REPORT

TIME	A/C	ALT	GAM	BETA	SPEED (KNOTS)	MU	ALPH	THROT	GEES	TI-MS	RANGE 1	RANGE 2	RANGE 3	RANGE 4	ANGLE OFF 1	ANGLE OFF 2	ANGLE OFF 3	ANGLE OFF 4	INFO STATE 1 2 3 4	OPTIC CONTACT 1 2 3 4
0.00	1	20000	0	0	474	0	22	1.00	5.00	0- 4	0	1000	5000	5000	0	107	120	130	0 0 3 3	0 0 1 1
	2	20000	0	0	474	0	22	.00	5.00	0- 8	1000	0	4030	4094	72	0	123	135	0 0 3 3	0 0 1 1
	3	20000	0	60	592	0	16	1.00	8.38	1- 9	5000	4030	0	872	0	3	0	85	1 3 0 0	1 1 0 0
	4	20000	0	60	592	0	11	1.00	5.51	0- 2	5000	4094	872	0	10	15	95	0	3 3 0 0	1 1 0 0
1.00	1	19969	-7	-11	465	-113	22	1.00	4.83	0- 2	0	892	4468	4451	0	101	122	128	0 0 3 3	0 0 1 1
	2	20123	9	-0	456	0	22	1.00	4.59	0- 8	892	0	3682	3710	72	0	137	145	0 0 3 3	0 0 1 1
	3	19970	-2	75	554	90	15	1.00	6.45	0- 9	4468	3682	0	472	28	34	0	57	7 7 0 0	0 0 0 0
	4	20000	-0	50	583	-80	9	1.00	4.61	1- 2	4451	3710	472	0	9	15	98	0	1 3 0 0	1 1 0 0
2.00	1	19806	-8	-22	459	-83	22	1.00	4.71	0- 2	0	643	3996	3884	0	98	124	127	0 0 3 3	0 0 1 1
	2	20069	-4	-0	444	-180	22	1.00	4.37	0- 8	643	0	3501	3396	63	0	150	154	0 0 3 3	0 0 1 1
	3	19862	-7	63	534	-104	17	1.00	6.83	0- 9	3996	3501	0	226	30	36	0	40	3 3 0 0	1 1 0 0
	4	19958	-2	41	579	-94	11	1.00	5.25	1- 2	3884	3396	220	0	10	16	128	0	1 3 0 0	1 1 0 0
3.00	1	19696	-8	-33	453	-82	22	1.00	4.60	0- 2	0	361	3682	3325	0	125	128	128	0 0 3 3	0 0 1 1
	2	20008	-5	11	438	80	22	1.00	4.25	0- 8	361	0	3454	3162	57	0	167	168	0 0 3 3	0 0 1 1
	3	19733	-9	49	506	-90	18	1.00	6.27	0- 9	3682	3454	0	330	31	32	0	52	3 3 0 0	1 1 0 0
	4	19901	-3	31	572	-84	13	1.00	6.35	1- 2	3325	3162	330	0	12	12	142	0	1 3 0 0	1 1 0 0
4.00	1	19580	-9	-44	447	-81	22	1.00	4.51	0- 4	0	711	3299	2811	0	137	132	131	0 0 3 3	0 0 1 1
	2	19786	-18	11	432	-180	22	1.00	4.16	0- 8	711	0	3378	2913	92	0	158	161	0 0 3 3	0 0 1 1
	3	19584	-11	35	482	-90	19	1.00	5.77	0- 9	3299	3378	0	564	34	25	0	56	3 3 0 0	1 1 0 0
	4	19821	-5	19	555	-89	16	.00	7.19	1- 2	2811	2913	564	0	14	4	139	0	1 7 0 0	1 0 0 0
5.00	1	19393	-15	-55	442	-109	22	1.00	4.43	0- 4	0	1525	3087	2400	0	130	136	135	0 0 3 3	0 0 1 1
	2	19488	-24	21	438	114	22	1.00	4.17	0- 8	1525	0	3279	2752	113	0	154	161	0 0 3 3	0 0 1 1
	3	19417	-12	22	459	-90	19	1.00	5.31	0- 9	3087	3279	0	788	37	16	0	57	3 3 0 0	1 0 0 0
	4	19727	-6	5	516	-88	18	.00	6.49	1- 2	2400	2752	788	0	15	18	139	0	1 7 0 0	1 0 0 0
6.00	1	19143	-20	-66	439	-106	22	1.00	4.40	0- 4	0	2401	2958	2105	0	140	140	142	0 0 3 3	0 0 1 1
	2	19049	-37	21	430	-180	22	1.00	4.24	0- 8	2401	0	3146	2728	116	0	146	152	0 0 3 3	0 0 1 1
	3	19231	-14	9	440	-90	20	1.00	4.93	0- 9	2958	3146	0	966	40	14	0	56	3 7 0 0	1 0 0 0
	4	19576	-11	-9	480	-101	19	.00	5.73	1- 2	2105	2728	966	0	18	40	139	0	1 7 0 0	1 0 0 0
7.00	1	18839	-24	-78	437	-104	22	1.00	4.41	0- 4	0	3392	2901	1931	0	142	143	149	0 0 3 3	0 0 1 1
	2	18528	-45	33	434	128	22	1.00	4.39	0- 8	3392	0	3061	2954	124	0	143	150	0 0 3 3	0 0 1 1
	3	19028	-17	-4	423	-90	20	1.00	4.62	0- 9	2901	3061	0	1103	43	28	0	54	3 7 0 0	1 0 0 0
	4	19386	-15	-22	448	-99	20	1.00	5.06	0- 2	1931	2954	1103	0	23	64	139	0	3 7 0 0	1 0 0 0
8.00	1	18487	-28	-90	437	-102	22	1.00	4.46	0- 4	0	4334	2905	1862	0	141	145	156	0 0 3 3	0 0 1 1
	2	17898	-58	33	440	-180	22	.00	4.60	0- 8	4334	0	3090	3383	120	0	139	140	0 0 3 3	0 0 1 1
	3	18807	-19	-17	409	-90	20	1.00	4.36	0- 9	2905	3090	0	1212	45	48	0	51	3 7 0 0	1 0 0 0
	4	19155	-19	-35	430	-99	20	1.00	4.74	0- 2	1862	3383	1212	0	29	83	140	0	3 7 0 0	1 0 0 0
9.00	1	18094	-32	-103	438	-101	22	1.00	4.54	0- 4	0	5153	2956	1890	0	138	146	163	0 0 3 3	0 0 1 1
	2	17209	-70	23	438	-162	22	1.00	4.67	0- 8	5153	0	3261	3918	112	0	133	130	0 0 3 3	0 0 1 1
	3	18571	-21	-29	396	-90	20	1.00	4.14	0- 9	2956	3261	0	1297	46	66	0	49	3 7 0 0	1 0 0 0
	4	18893	-22	-48	416	-97	20	1.00	4.48	0- 2	[illegible]	3918	1297	0	34	98	141	0	3 7 0 0	1 0 0 0

values are listed below with succinct definitions. A more detailed discussion can be found in Section 4.4.1.

Maneuver State	
1	Gun-firing pursuit course
2	Offensive
3	Defensive action 1
4	" 2
5	" 3
6	" 4
7	Unaware
8	Formation
9	Bracket
10	Dead
11	Missile Evasion
12	Bingo Fuel
13	Disengage
14	Chandelle
15	Split-S
16	Immelman
17	High Speed Yo-Yo
18	Barrel Roll
19	Bomber Defense
20	Bomber Penetration

RANGE - the ranges from the aircraft to all other aircraft in the engagement. (feet) An aircraft's range to itself is printed as 0.

ANGLE OFF - the off angles between the aircraft and all other aircraft in the engagement. (degrees) An aircraft's off angle to itself is printed as 0.

INFO STATE - the information states of the aircraft with respect to all other aircraft in the engagement. This prints as a 0 for any aircraft with itself or with any aircraft on its side. A value of 9 indicates unaware, other values are defined as follows:

	NO IFF	IFF
Tracking	1	2
Active	3	4
Passive	5	7
Aware	7	8

4.3.2 STANDARD AIRCRAFT REPORT (WITH WEAPONS)

The atandard aircraft report shown on Figure 4-11 has been adapted without change from that used in PACAM II. With the integration of dynamic weapon evaluation into the program, the standard aircraft report is modified to display this effect. Figure 4-12 shows an example of this print-out version, with the additional output boxed in for emphasis. Each line on the additional output represents a status report for each weapon active at the minor time pulse (DLT2) shown.

```
                                SPEED                                             ----RANGE----       ANG OFF     INFO      OPTIC
TIME  A/C   ALT   GAM   BETA  (KNOTS)   MU   ALPH THROT  GEES TI-MS      1      2         1   2     STATE     CONTACT
                                                                                                       1 2        1 2

  0.00 1    100     0      0    474      0     2   .61  7.33  2- 2       0  15000         0  30      9 1        0 1
       2    100     0      0    355      0     3   .22  1.01  1-20   15000      0       150   0      1 9        0 0

  1.00 1    100     0    -17    470    -82     9  1.00  5.41  2- 2       0  14750         0  13      9 1        0 1
       2    100     0      0    356     -7     3   .27  1.08  1-20   14750      0       151   0      1 9        1 0
PP K5,ID 1,L1,R2,T3,MA1

  2.00 1    100     0    -29    482    -79     7  1.00  1.05  2- 2       0  14459         0   1      9 1        0 1
       2    100     0      1    357     23     3   .33  1.18  1-20   14459      0       151   0      1 9        1 0
LN K5,ID 1,L1,R2,T3,MA2,R 14154.,V  843.,F  1.000

  3.00 1    100     0    -28    500     18     2  1.00  1.15  2- 2       0  14154         0   1      9 1        0 1
       2    100     0      3    358     32     3   .39  1.02  1-20   14154      0       150   0      1 9        1 0
KW K5,ID 1,L1,R2,T3,MA3,R 13876.,V 1086.,F  1.000,TM   .6
KW K5,ID 1,L1,R2,T3,MA3,R 13816.,V 1124.,F  2.549,TM   .7
KW K5,ID 1,L1,R2,T3,MA3,R 13753.,V 1161.,F  2.668,TM   .8
KW K5,ID 1,L1,R2,T3,MA3,R 13696.,V 1198.,F  2.753,TM   .9
KW K5,ID 1,L1,R2,T3,MA3,R 13615.,V 1234.,F  2.830,TM  1.0

  4.00 1    100     0    -27    517     30     2  1.00  1.18  2- 2       0  13818         0   1      9 1        0 1
       2    100     0      4    359     24     3   .44  1.12  5-20   13818      0       150   0      3 9        1 0
KW K5,ID 1,L1,R2,T3,MA3,R 13541.,V 1269.,F  2.921,TM  1.1
KW K5,ID 1,L1,R2,T3,MA3,R 13463.,V 1303.,F  3.001,TM  1.2
KW K5,ID 1,L1,R2,T3,MA3,R 13382.,V 1337.,F  3.055,TM  1.3
KW K5,ID 1,L1,R2,T3,MA3,R 13297.,V 1371.,F  3.103,TM  1.4
KW K5,ID 1,L1,R2,T3,MA3,R 13210.,V 1404.,F  3.146,TM  1.5
KW K5,ID 1,L1,R2,T3,MA3,R 13119.,V 1436.,F  3.184,TM  1.6
KW K5,ID 1,L1,R2,T3,MA3,R 13025.,V 1468.,F  3.219,TM  1.7
KW K5,ID 1,L1,R2,T3,MA3,R 12927.,V 1500.,F  3.249,TM  1.8
KW K5,ID 1,L1,R2,T3,MA3,R 12827.,V 1531.,F  3.276,TM  1.9
KW K5,ID 1,L1,R2,T3,MA3,R 12723.,V 1561.,F  3.298,TM  2.0

  5.00 1    100     0    -26    535     32     1  1.00  1.20  2- 2       0  13454         0   1      9 1        0 1
       2    100     0      6    361     27     3   .50  1.08  5-20   13454      0       150   0      3 9        1 0
KW K5,ID 1,L1,R2,T3,MA3,R 12617.,V 1592.,F  3.317,TM  2.1
KW K5,ID 1,L1,R2,T3,MA3,R 12508.,V 1622.,F  3.329,TM  2.2
KW K5,ID 1,L1,R2,T3,MA3,R 12395.,V 1651.,F  3.337,TM  2.3
KW K5,ID 1,L1,R2,T3,MA3,R 12280.,V 1680.,F  3.340,TM  2.4
KW K5,ID 1,L1,R2,T3,MA3,R 12162.,V 1709.,F  3.340,TM  2.5
KW K5,ID 1,L1,R2,T3,MA3,R 12042.,V 1737.,F  3.336,TM  2.6
KW K5,ID 1,L1,R2,T3,MA3,R 11919.,V 1765.,F  3.328,TM  2.7
KW K5,ID 1,L1,R2,T3,MA3,R 11792.,V 1793.,F  3.317,TM  2.8
KW K5,ID 1,L1,R2,T3,MA3,R 11663.,V 1820.,F  3.301,TM  2.9
KW K5,ID 1,L1,R2,T3,MA3,R 11532.,V 1847.,F  3.282,TM  3.0
LO L2,P 5,CLASS 1,TON  .1,R 11532.,PROP 0.000,LPSL11

  6.00 1    100     0    -24    553     34     1  1.00  1.23  2- 2       0  13064         0   1      9 1        0 1
       2    100     0      7    363     23     3  1.00  1.05  5-20   13064      0       150   0      3 9        1 0
KW K5,ID 1,L1,R2,T3,MA3,R 11398.,V 1873.,F  3.260,TM  3.1
LO L2,P 5,CLASS 1,TON  .2,R 11398.,PROP  .013,LPSL11
KW K5,ID 1,L1,R2,T3,MA3,R 11261.,V 1899.,F  3.230,TM  3.2
LO L2,P 5,CLASS 1,TON  .3,R 11261.,PROP  .036,LPSL11
KW K5,ID 1,L1,R2,T3,MA3,R 11122.,V 1925.,F  3.197,TM  3.3
LO L2,P 5,CLASS 1,TON  .4,R 11122.,PROP  .070,LPSL11
KW K5,ID 1,L1,R2,T3,MA3,R 10981.,V 1950.,F  3.161,TM  3.4
LO L2,P 5,CLASS 1,TON  .5,R 10981.,PROP  .105,LPSL11
KW K5,ID 1,L1,R2,T3,MA3,R 10837.,V 1975.,F  3.122,TM  3.5
LO L2,P 5,CLASS 1,TON  .6,R 10837.,PROP  .141,LPSL11
KW K5,ID 1,L1,R2,T3,MA3,R 10691.,V 1999.,F  3.079,TM  3.6
LO L2,P 5,CLASS 1,TON  .7,R 10691.,PROP  .179,LPSL11
KW K5,ID 1,L1,R2,T3,MA3,R 10542.,V 2023.,F  3.034,TM  3.7
LO L2,P 5,CLASS 1,TON  .8,R 10542.,PROP  .218,LPSL11
KW K5,ID 1,L1,R2,T3,MA3,R 10391.,V 2047.,F  2.986,TM  3.8
LO L2,P 5,CLASS 1,TON  .9,R 10391.,PROP  .259,LPSL11
KW K5,ID 1,L1,R2,T3,MA3,R 10239.,V 2070.,F  2.935,TM  3.9
LO L2,P 5,CLASS 1,TON 1.0,R 10239.,PROP  .301,LPSL11
KW K5,ID 1,L1,R2,T3,MA3,R 100[illegible].,V 2092.,F  2.882,TM  4.0
LO L2,P 5,CLASS 1,TON 1.1,R [illegible].,PROP  .[illegible],LPSL11
```

FIGURE 4-12
STANDARD PRINTED REPORT WITH WEAPONS

4.3.2.1 MISSILE OUTPUT

For missiles, the format of each line is described below. The first six variables represent:

The flight phase	PR	Prelaunch
	LN	Launch
	KW	Flight
	KV	End game
The internal index	Ka	Where $5 \leq a \leq 10$
Missile ID	IDb	Where b is a unique, internally assigned, identification number
Launching aircraft	Lc	Where c is the aircraft number
Target aircraft or missile	Rd	Where d is the aircraft or missile ID
Weapon type	Te	Where e is defined: 3 Blue LR missile 4 Red LR missile 5 Blue SR missile 6 Red SR missile
Maneuver state	Mf	Where f is the missile maneuver state: 80 Dead 81 Prelaunch 82 Launch 83 Guidance enable 84 Proportional navigation, $R > R^*$ 85 Proportional navigation, $R \leq R^*$ 86 Break lock 87 Approach

A more detailed discussion of the missile maneuver states appears in Section 4.4.2.

Thus the partial output line: KW, K5, ID4, L1, R3, T3, M84 represents a missile with internal index of 5, launched 4th in this run, from aircraft 1 against aircraft 3. Is a long-range blue missile type, flying long-range proportional navigation.

Those six identifiers are all that are printed at launch initiation (PR). At actual missile separation (LN) three more parameters are added:

R Range to target. (feet)

V Velocity of missile. (feet/second)

E ETA, the missile gee loading

After launch a fourth parameter is added

TM Time of flight. (seconds)

and finally at end game time, the closest approach distance and the outcome are shown

RC Closest approach distance. (feet)

DEa Where *a* is the number of the dead aircraft or missile
a=0 indicates no kill.

4.3.2.2 LASER OUTPUT

For laser weapons, the format of each line is as follows:

Identification	LQ	Identifies this as being a line of laser output
Firing aircraft	La	Where a is the aircraft ID
Target aircraft or missile	Rb	Where b is the aircraft or missile ID
Target class	Class c	$1 \leq c \leq 5$, where c is the kill class 2 of the particular target (see classified supplement for definitions)
Time on	TON	Length of time for which the laser has been firing. (seconds
Range	R	Range to target. (feet)
Probability	PROB	Probability of kill
Result	LRSLT d	Where d is a numeric code which specifies the result of the laser firing (see classified supplement for definitions).

4.3.3 FIRING SCREEN OUTPUT

At each major time pulse, PACAM IV evaluates (through programs SCREEN and FIRE) the opportunities and occasion of weapons launch. A report of this activity is written to a local file named TAPE4. A typical page of this report is displayed as Figure 4-13, and described below.

The column headings are felt to be self-descriptive, subject to the following remarks.

TARGET - may be either a missile or aircraft. If target is a missile, the number shown is the internal missile index described in the previous section.

WEAPON TYPE -
1 Long-range missile
2 Short-range missile
3 Laser
4 Guns

Entries under the heading "WEAPON TYPE" represent the fire control and weapon launch status according to the following codes. The conditions referred to are from Figure 4-8.

Status Code	Explanation
0	Not applicable
1	Lock-on conditions not satisfied (conditions 1-3)
2	In lock-on process, insufficient time
3	IFF required but not satisfied (condition 13)
4	System assessment conditions 4-6, 12 not satisfied (break lock not required)
5	System assessment conditions 7-11 not satisfied (break lock)
6	In system assessment process, insufficient time

FIGURE 4-13

FIRING SCREEN OUTPUT

WEAPON FIRING SCREEN RESULTS

TIME	AIRCFT FIRING	TARGET	WEAPON TYPE 1	2	3	4	TYPE FIRED
0.00	1	2	1	1	1	0	0
	2	1	9	1	1	0	0
1.00	1	2	1	1	1	0	0
	2	1	9	1	9	0	3
2.00	1	2	9	2	8	0	1
	2	1	8	1	9	0	3
3.00	1	2	8	2	8	0	0
	2	1	8	1	9	0	3
4.00	1	2	8	2	8	0	0
	2	6	8	1	9	0	3
5.00	1	2	8	2	8	0	0
	2	5	9	1	9	0	3
6.00	1	2	8	2	8	0	0
	2	5	8	1	9	0	3
7.00	1	2	8	2	8	0	0
	2	5	8	1	9	0	3
8.00	1	2	9	2	8	0	1
	2	5	8	1	9	0	3
9.00	1	2	8	2	8	0	0
	2	1	8	1	9	0	3
10.00	1	2	8	2	8	0	0
	2	6	8	1	9	0	3
11.00	1	2	8	4	8	0	0
	2	6	9	1	9	0	3
12.00	1	2	8	4	8	0	0
	2	6	9	1	9	0	3
13.00	1	2	8	4	8	0	0
	2	1	9	1	9	0	3

Status Code	Explanation (Cont'd)
7	Aircraft maneuver problem only (conditions 14-17)
8	All screen conditions satisfied, weapon not available
9	Weapon firing possible

TYPE FIRED - the entry here indicates the type of weapon that was actually fired. A 0 indicates that no weapon was fired.

4.3.4 SPECIAL REPORTS

Information useful for detailed inspection of any set of parameters computed by PACAM IV can be made available through modification of the WRITE and FORMAT statements in routine OUT7. This additional report is then written to local file TAPE7.

An example of one such special report is shown in Figure 4-14. An explanation of the column headings follows:

TIME - the time in the engagement. (seconds)

A/C - this is the aircraft number that was input on the initial condition form.

X - the inertial x-coordinate of the aircraft. (feet)

Y - the inertial y-coordinate of the sircraft. (feet)

Z - the inertial z-coordinate of the aircraft. (feet) (=ALT).

VST - the stall velocity of the aircraft. (feet/second)

VCORN - the corner velocity of the aircraft. (feet/second)

V(FPS) - the velocity of the aircraft. (feet/second)

VSND - the speed of sound at altitude Z. (feet/second)

MACH - the mach number of the aircraft.

RHO - the atmospheric density at altitude Z. (slugs/cubic foot)

Q - the dynamic pressure of the aircraft. (pounds/square foot)

U - the dynamic pressure at the speed of sound divided by the wing loading of the aircraft.

CD - the drag coefficient of the aircraft.

FIGURE 4-14

SPECIAL REPORT

Time	A/C	X	Y	Z	VST	VCORN	V(FPS)	VSND	MACH	RHO	Q	U	CD
50.00	1	11607.0	-1367.3	1541.1	261.576	809.165	620.684	1111.115	.55861344	.00227156	437.5578	17.7769	.23338673
	2	12892.2	-2609.2	1976.2	264.103	816.738	761.082	1109.433	.68600994	.00224247	649.4722	17.3856	.06584662
	3	11908.0	-4117.4	1779.3	247.357	750.578	535.120	1110.195	.48200562	.00225560	322.9497	21.2044	.18082034
	4	11723.7	-2359.8	1849.3	248.792	755.195	659.151	1109.924	.59387039	.00225093	488.9914	20.9503	.09908418
51.00	1	11449.3	-790.1	1417.1	261.030	807.532	611.063	1111.593	.54971847	.00227991	425.6568	17.8667	.23444990
	2	12728.0	-1798.0	1788.4	263.369	814.543	753.737	1110.160	.67894453	.00225500	640.5538	17.5056	.03214850
	3	11652.3	-3663.2	1635.8	246.755	748.623	540.662	1110.749	.48675411	.00226521	331.0769	21.3293	.33650000
	4	11675.7	-1788.5	1673.4	248.144	753.089	643.653	1110.604	.57955251	.00226269	466.7045	21.0856	.04822225
52.00	1	11187.0	-252.4	1387.7	260.850	806.992	600.789	1111.707	.54042037	.00228189	411.8208	17.8950	.23556125
	2	12528.1	-1088.8	1631.1	262.756	812.711	753.411	1110.767	.67827986	.00226552	642.9876	17.6066	.04604426
	3	11548.9	-3182.8	1476.2	246.095	746.483	516.886	1111.365	.46509135	.00227593	304.0313	21.4676	.33650000
	4	11537.5	-1175.4	1544.9	247.673	751.556	641.460	1111.100	.57731950	.00227131	467.2886	21.1849	.12727005
53.00	1	10830.0	212.4	1446.2	261.009	807.467	586.632	1111.481	.52779342	.00227794	391.9629	17.8659	.23707049
	2	12258.1	-404.9	1510.0	262.286	811.306	748.123	1111.235	.67323615	.00227365	636.2687	17.6846	.09851701
	3	11574.0	-2701.2	1347.7	245.550	744.718	498.890	1111.861	.44869782	.00228459	284.3065	21.5822	.33650000
	4	11317.8	-558.0	1506.4	247.532	751.099	618.974	1111.248	.55700741	.00227390	435.5969	21.2146	.32985464
54.00	1	10611.2	737.2	1419.1	260.839	806.956	569.224	1111.586	.51208303	.00227977	369.3415	17.8927	.23894828
	2	11883.6	224.0	1508.5	262.280	811.280	727.987	1111.240	.65504037	.00227376	602.3736	17.6856	.04112969
	3	11644.3	-2225.2	1312.4	245.345	744.055	482.442	1111.997	.43385166	.00228697	266.1458	21.6236	.04975541
	4	10965.2	-145.0	1513.6	247.479	750.928	574.075	1111.221	.51661661	.00227341	374.6152	21.2227	.30834151
55.00	1	10278.7	1174.4	1318.4	260.386	805.599	558.363	1111.974	.50213940	.00228656	356.4436	17.9676	.24013679
	2	11598.5	878.6	1441.0	262.019	810.506	717.924	1111.501	.64590549	.00227829	587.1338	17.7292	.06139216
	3	11697.5	-1786.5	1292.7	245.196	743.575	501.873	1112.073	.45129540	.00228830	288.1848	21.6528	.10075053
	4	10768.5	352.1	1442.7	247.141	749.833	540.07[illegible]	1111.494	.48589665	.00227818	332.2471	21.2913	.07795163
56.00	1	9851.5	1514.2	1236.0	260.004	804.455	552.841	1112.292	.49702854	.00229213	350.2760	18.0307	.24074766
	2	11209.3	1462.4	1350.7	261.669	809.461	706.328	1111.849	.63527277	.00228438	569.8382	17.7878	.08513135
	3	11672.9	-1222.8	1263.4	244.796	742.273	512.215	1112.418	.46045239	.00229434	300.9769	21.7373	.11894997
	4	10488.5	823.6	1356.5	246.749	748.562	555.118	1111.827	.49928431	.00228399	351.9129	21.3718	.33650000
57.00	1	9519.2	1944.8	1174.3	259.702	803.550	546.834	1112.530	.49152340	.00229631	343.3306	18.0804	.24140567
	2	10722.0	1946.6	1278.8	261.392	808.631	690.769	1112.327	.62112447	.00228924	546.1680	17.8344	.05199802
	3	11573.5	-712.3	1142.8	244.499	741.318	523.589	1112.651	.47057754	.00229845	315.0540	21.7992	.03589353
	4	10164.6	1175.6	1280.9	246.395	747.417	524.858	1112.119	.47194377	.00228910	315.2953	21.4444	.14736535
58.00	1	9057.6	2279.5	1128.2	259.460	802.826	540.240	1112.707	.48551811	.00229943	335.5548	18.1198	.24213018
	2	10387.0	2485.3	1219.0	261.161	807.941	682.596	1112.357	.61364970	.00229320	534.2661	17.8734	.09012046
	3	11463.6	-180.0	1059.7	244.266	740.564	545.191	1112.817	.48991954	.00230137	342.0210	21.8474	.08357884
	4	9784.5	1955.2	1233.2	246.144	746.605	529.876	1112.303	.47637757	.00229232	321.8061	21.4953	.06613860
59.00	1	8613.4	2560.6	1053.9	259.264	802.238	533.403	1112.840	.47931708	.00230176	327.4469	18.1516	.24308405
	2	9803.2	2518.2	1172.7	260.982	807.407	665.891	1112.536	.59853400	.00229642	509.1281	17.9036	.09794204
	3	11273.7	343.4	1071.8	244.086	739.986	557.530	1112.925	.50095919	.00230326	357.9729	21.8837	.06969308
	4	9403.8	1974.3	1177.1	245.899	745.811	540.240	1112.519	.48560837	.00229612	335.0713	21.9465	.33650000

4.3.5 GRAPHICS INTERFACE OUTPUT

In order to provide input to graphics programs at Eglin Air Force Base and Kirtland Air Force Base, two subroutines in PACAM IV have been written to reorder, format and redimension the flight path data and aircraft orientation, as required.

These two output files are referred to as the B tape and the PACED tape in Table 4-1, and are for use at Eglin AFB and Kirtland AFB respectively.

The format of the B tape is described in the PACAM II Users Manual January, 1976, A. T. Kearney, pp. 50-56.

The format of the PACED tape is described in Users Manual for the Trajectory Analysis Computer Program, BDM, pp. 46-50.

Both graphics packages provide output in the form of movies and still pictures. Examples of the latter are provided in Figures 4-15 through 4-18, and on the cover of this manual.

Figures 4-15 through 4-17 were generated by the graphics package at Eglin AFB. Figure 4-18, which is taken from a PACAM IV run where one side is a bomber, was generated by the graphics package at Kirtland AFB.

FIGURE 4-15

PERSPECTIVE VIEW

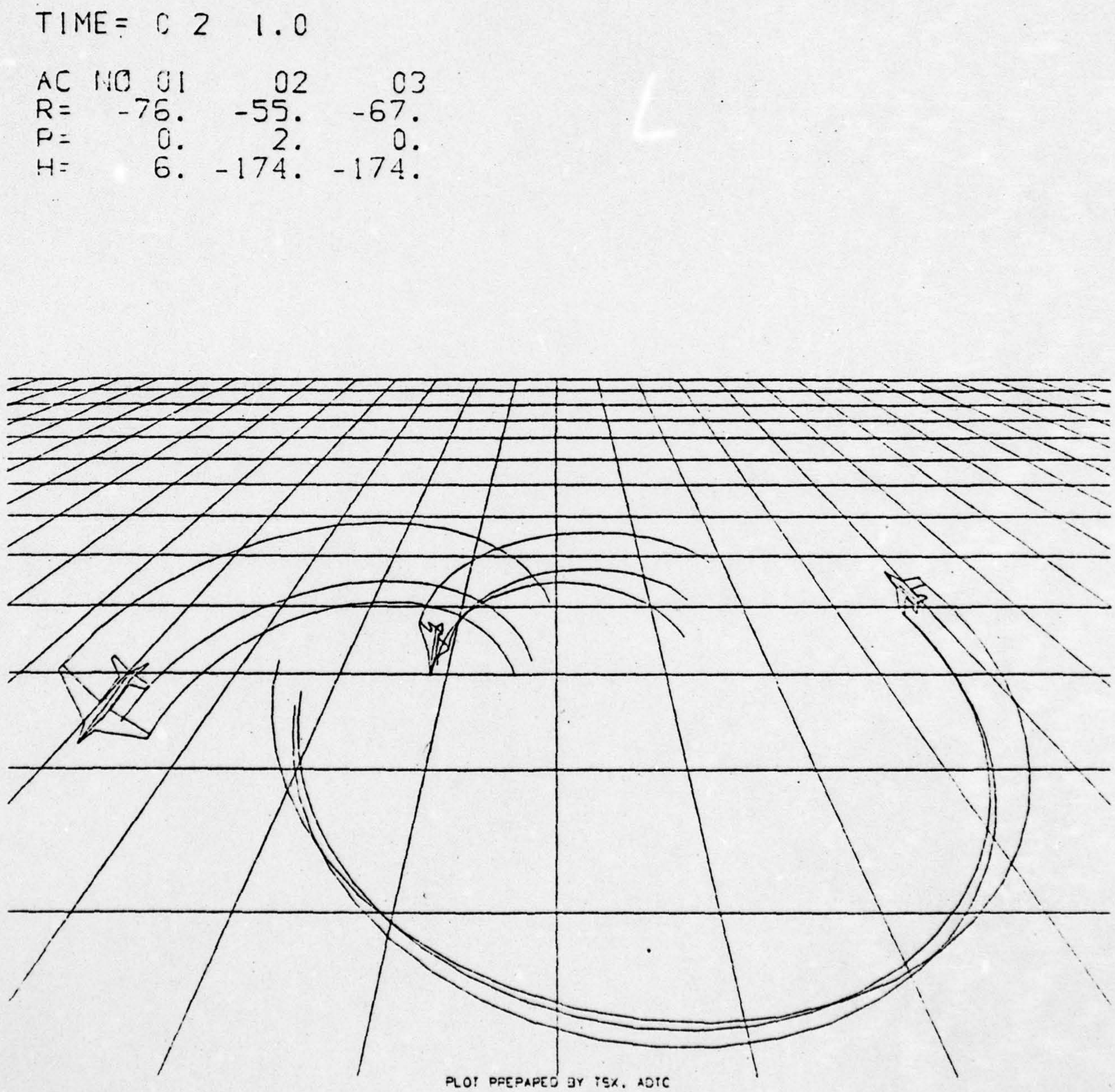


FIGURE 4-16

PILOT'S-EYE VIEW

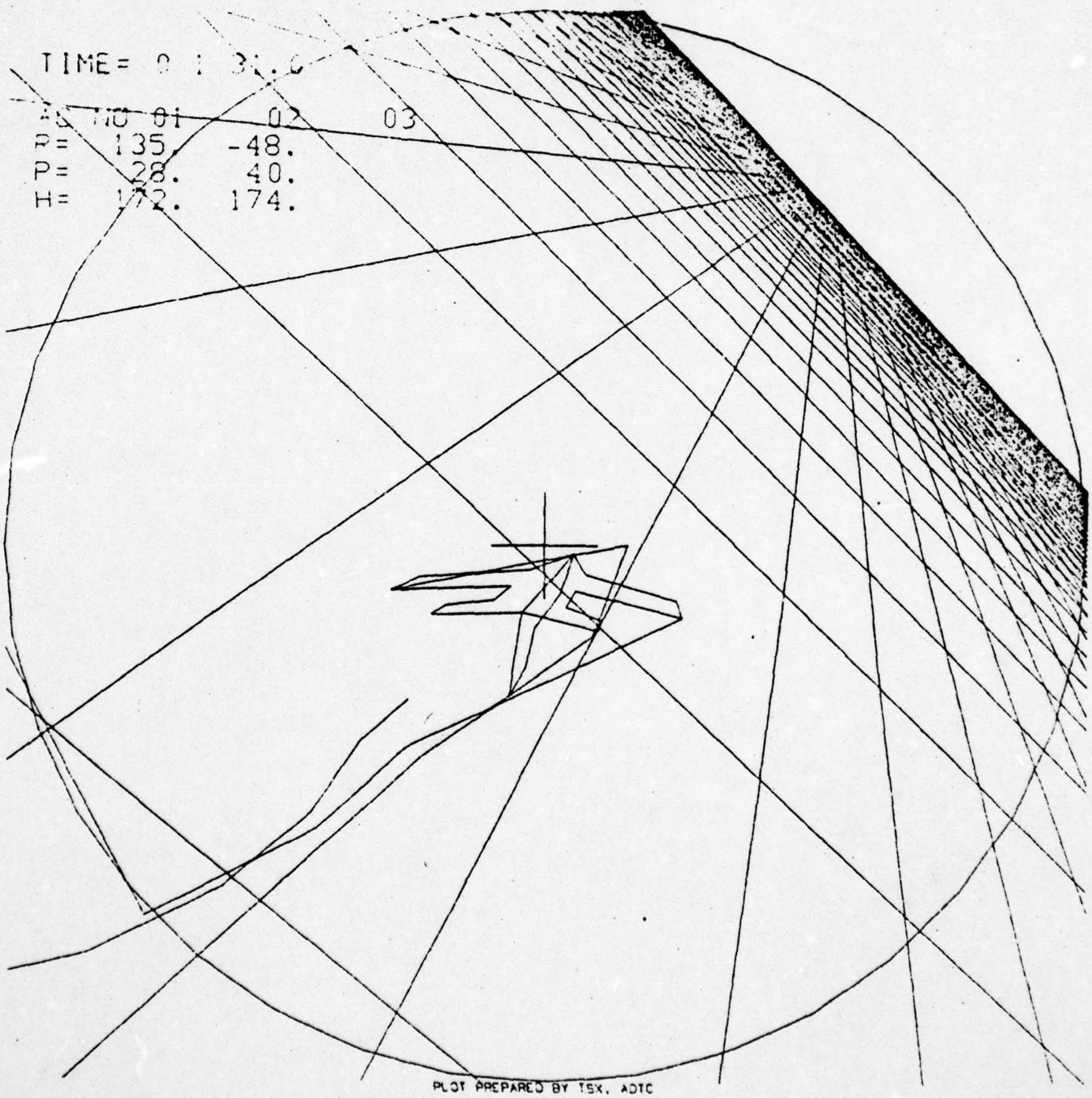


FIGURE 4-17

GROUND TRACE

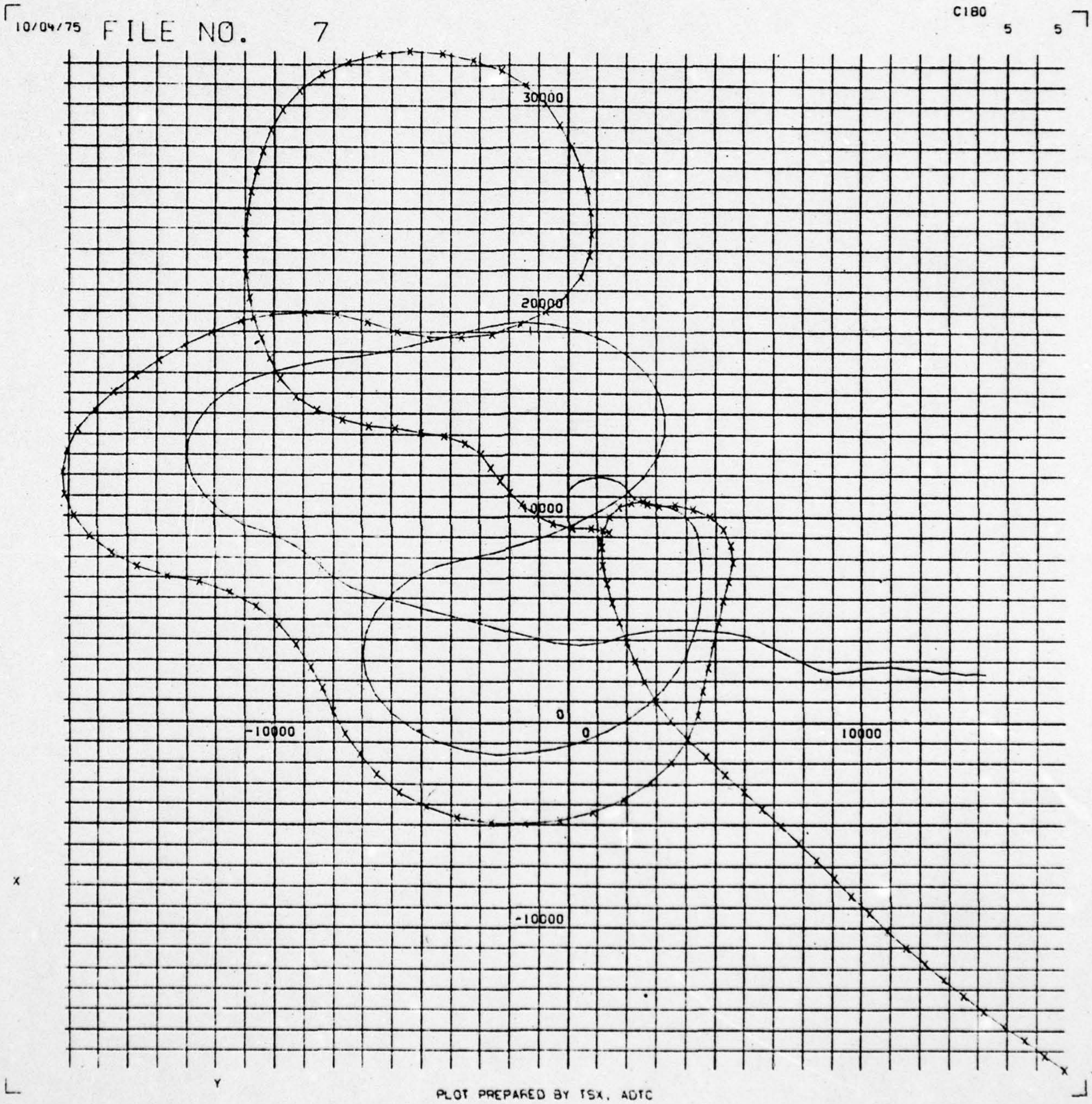
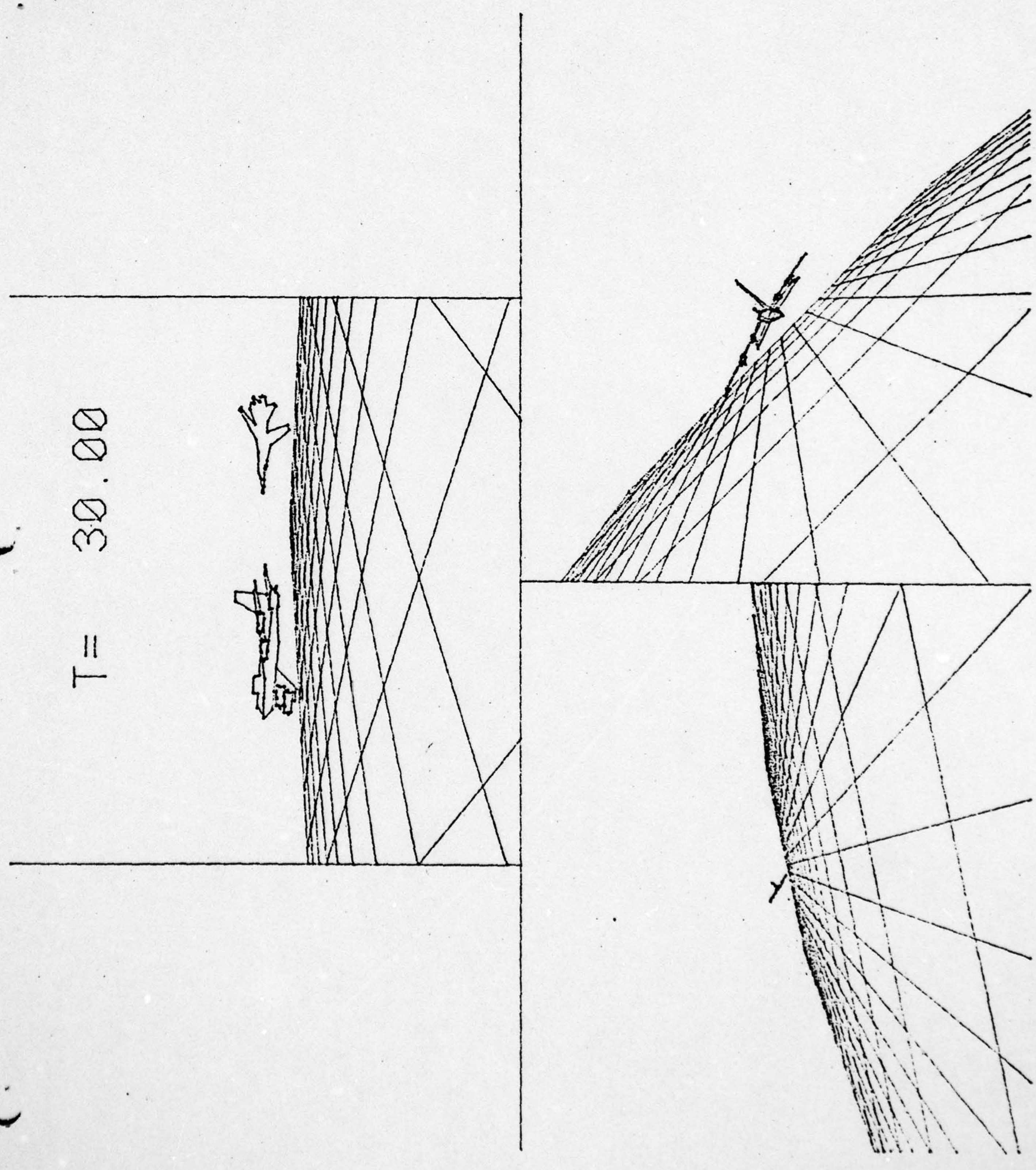


FIGURE 4-18

COMPUTER PLOTS OF PACAM IV OUTPUT



4.3.6 Narrative Output

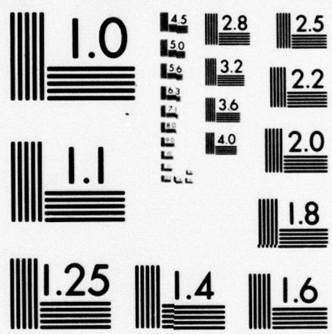
As an alternate to, or in addition to, the detailed output described previously, PACAM IV has the ability to list only significant events occurring during the duel. This output is written to the local file TAPE9. An example is shown in Figure 4-19, and should be completely self-explanatory.

AD-A069 222 KEARNEY (A T) INC CHICAGO IL CAYWOOD-SCHILLER DIV F/G 15/7
PACAM IV MULTIPLE AIRCRAFT THREE DIMENSIONAL AIR-TO-AIR COMBAT.--ETC(U)
APR 78 M D DLOOGATCH, D H SCHILLER F08635-77-C-0168

UNCLASSIFIED NL

2 OF 2
AD
A069 222

END
DATE
FILMED
7 -79
DDC



MICROCOPY RESOLUTION TEST CHART

FIGURE 4-19

NARRATIVE OUTPUT

```
SUMMARY OF SIGNIFICANT EVENTS

  TIME

  0.00    RED AIRCRAFT 1 (TYPE 1) DETECTS BLUE AIRCRAFT 2 (TYPE 2) BY RADAR.
  0.00    RED AIRCRAFT 1 (TYPE 1) DETECTS BLUE AIRCRAFT 2 (TYPE 2) OPTICALLY.
  0.00   BLUE AIRCRAFT 2 (TYPE 2) DETECTS  RED AIRCRAFT 1 (TYPE 1) BY RADAR.
  1.00   BLUE AIRCRAFT 2 (TYPE 2) DETECTS  RED AIRCRAFT 1 (TYPE 1) OPTICALLY.
  2.00    RED AIRCRAFT 1 (TYPE 1) FIRES MISSILE  1 (TYPE 3) AT BLUE AIRCRAFT 2 (TYPE 2) FROM A DISTANCE OF 14459 FEET.
  8.00    RED AIRCRAFT 1 (TYPE 1) FIRES MISSILE  2 (TYPE 3) AT BLUE AIRCRAFT 2 (TYPE 2) FROM A DISTANCE OF 12212 FEET.
  9.00   BLUE AIRCRAFT 2 (TYPE 2) DETECTS  RED AIRCRAFT 1 (TYPE 1) BY RADAR.
 10.00   BLUE AIRCRAFT 2 (TYPE 2) DETECTS  RED MISSILE  1 (TYPE 3) OPTICALLY.
 12.00   BLUE AIRCRAFT 2 (TYPE 2) DETECTS  RED MISSILE  2 (TYPE 3) OPTICALLY.
 13.00   BLUE AIRCRAFT 2 (TYPE 2) DETECTS  RED AIRCRAFT 1 (TYPE 1) BY RADAR.
 14.00    RED MISSILE  1 (TYPE 3) REACHES POINT OF CLOSEST APPROACH TO BLUE AIRCRAFT 2 (TYPE 2).  RANGE IS   738 FEET.
         P(KILL) IS 0.000.  BLUE AIRCRAFT 2 CONTINUES TO FLY.
 17.00    RED MISSILE  2 (TYPE 3) REACHES POINT OF CLOSEST APPROACH TO BLUE AIRCRAFT 2 (TYPE 2).  RANGE IS   733 FEET.
         P(KILL) IS 0.000.  BLUE AIRCRAFT 2 CONTINUES TO FLY.
 31.00    RED AIRCRAFT 1 (TYPE 1) DETECTS BLUE AIRCRAFT 2 (TYPE 2) OPTICALLY.
 31.00   BLUE AIRCRAFT 2 (TYPE 2) DETECTS  RED AIRCRAFT 1 (TYPE 1) OPTICALLY.
 34.00    RED AIRCRAFT 1 (TYPE 1) DETECTS BLUE AIRCRAFT 2 (TYPE 2) OPTICALLY.
 35.00   BLUE AIRCRAFT 2 (TYPE 2) DETECTS  RED AIRCRAFT 1 (TYPE 1) BY RADAR.
 35.00   BLUE AIRCRAFT 2 (TYPE 2) DETECTS  RED AIRCRAFT 1 (TYPE 1) OPTICALLY.
 37.00    RED AIRCRAFT 1 (TYPE 1) DETECTS BLUE AIRCRAFT 2 (TYPE 2) OPTICALLY.
 38.00   BLUE AIRCRAFT 2 (TYPE 2) DETECTS  RED AIRCRAFT 1 (TYPE 1) OPTICALLY.
 41.00   BLUE AIRCRAFT 2 (TYPE 2) DETECTS  RED AIRCRAFT 1 (TYPE 1) OPTICALLY.
 43.00    RED AIRCRAFT 1 (TYPE 1) DETECTS BLUE AIRCRAFT 2 (TYPE 2) BY RADAR.
 47.00    RED AIRCRAFT 1 (TYPE 1) DETECTS BLUE AIRCRAFT 2 (TYPE 2) BY RADAR.
 85.00   BLUE AIRCRAFT 2 (TYPE 2) DETECTS  RED AIRCRAFT 1 (TYPE 1) BY RADAR.
```

4.4 MANEUVER STATES

4.4.1 AIRCRAFT MANEUVER STATES

The following is a set of definitions for the maneuver states available to aircraft, as listed in Section 4.3.1.

Maneuver State 1 (Lead Pursuit Course)

An aircraft in this maneuver state is attempting to maintain a lead angle appropriate for weapon firing. This lead angle is based upon exponential bullet slowdown or constant bullet velocity at user option. Full throttle is used to provide rapid approach to gun range; the throttle is then adjusted in order to achieve a specified overtake velocity (VOVER). This overtake velocity may range from low, for remaining within gun range, to a value desirable for a high speed passing attack.

Maneuver State 2 (Offense)

An aircraft in this maneuver state is either attempting to achieve or already flying a weapons firing course. A maximum gee turn is attempted, with corner velocity desired. Full throttle is maintained, and velocity controlled by manipulation of the aircraft nose.

Maneuver State 3 (Defensive Action 1)

An aircraft in this maneuver state is performing a "jink" (e.g., randomly selecting full or idle throttle, with maximum gee turns in random directions). There is a built-in three second limit for each random jink, and provision is made to avoid smooth maneuvers.

Maneuver State 4 (Defensive Action 2)

An aircraft in maneuver state 4 reacts to an opponent by attempting a maximum gee turn into the line of sight at full throttle.

Maneuver State 5 (Defensive Action 3)

An aircraft in maneuver state 5 reacts to an opponent by diving for the deck (i.e., 100 foot level) at an angle of 30 degrees. Full throttle is applied. At the user's option, the aircraft may make a series of 30 degree clearing turns after it has reached the deck.

Maneuver State 6 (Defensive Action 4)

An aircraft in maneuver state 6 reacts to an opponent by attempting to climb to a given escape altitude at a given mach number. The escape altitude and mach number are user inputs.

Maneuver State 7 (Unaware)

An aircraft in the unaware state will fly straight and level, maintaining its current throttle and heading.

Maneuver State 8 (Formation)

An aircraft assigned to the wingman position will attempt to maintain a fixed position relative to the leader throughout the time he remains in this maneuver state. The aircraft will adjust throttle and heading in an effort to maintain formation; his success is a strong function of the actions of the leader.

Maneuver State 9 (Bracket)

The aircraft in a bracket maneuver is attempting to achieve an extended formation position on the side opposite to that being attacked by his partner.

Maneuver State 10 (Dead)

An aircraft killed during the combat will enter and maintain a flat spiral till it impacts on the ground. At the time of kill his sensors are turned off and all other sensor information concerning him is canceled.

Maneuver State 11 (Evade Missile)

An aircraft which has run out of fuel or weapons will attempt to disengage. The exact maneuver used will depend upon the relative positions of the aircraft at the point when the maneuver state is first entered.

Maneuver State 13 (Disengage)

An aircraft attempting to disengage from the combat because of enemy action will strive for a heading opposite that being flown at maneuver initiation.

Maneuver State 14 (Chandelle)

An aircraft in this maneuver state is performing a climbing turn, intending to exchange speed for altitude. Turning rate and desired velocity may be set by the user in the subroutine argument list.

Maneuver State 15 (Split-S)

The Split-S maneuver consists of a 180° turn downward in the vertical plane.

Maneuver State 16 (Immelman)

The Immelman turn consists of a 180° turn upward in the vertical plane.

Maneuver State 17 (High Speed Yo-Yo)

The high speed yo-yo is employed by an aircraft on or near a pursuit course in order to relieve excess gee forces and/or reduce closing speed.

Maneuver State 18 (Barrel Roll)

An aircraft in this maneuver state is following a constant gee helical path. The parameters of the barrel roll (period and gee loading) may be set by the user in the subroutine argument list.

Maneuver State 19 (Bomber Penetration)

An aircraft in this maneuver state is attempting to reach an enemy ground target, via a two segment path. If forced off course during the first segment, course will be reset directly to the target, when possible.

Maneuver State 20 (Bomber Defense)

An aircraft in this state is maneuvering to keep an opponent in his tail cone at a specified off angle, so as to allow use of a tail defense weapon.

4.4.2 MISSILE MANEUVER STATES

The following list comprises all of the maneuver states presently available to missiles in PACAM IV.

Maneuver State 80 - Dead

In this state, the missile associated with a given internal index has been removed from the battle, or has not yet been activated.

Maneuver State 81 - Prelaunch

A missile in this state has been assigned to a target, and firing has been initiated. However, it has not yet separated from the launching aircraft.

Maneuver State 82 - Guidance Enable

In this state the missile has left the aircraft, and is flying a straight line path, awaiting guidance enablement.

Maneuver 83 - Proportional Navigation, Long Range

The missile is flying a path attempting to keep the angular rate of the velocity vector proportional to the angular rate of the line of sight. Range is greater than RSTAR, which is a data input.

Maneuver State 84 - Proportional Navigation, Short Range

When a missile flying proportional navigation approaches within RSTAR of the target, a new set of constants is used. The new constants may or may not be different from the long-range constants.

<u>Maneuver State 85</u> - Pursuit Course

The missile is flying a pure pursuit course, attempting to keep its longitudinal axis pointing at the target.

<u>Maneuver State 86</u> - Approach

The missile in this maneuver state is flying a straight line course, having closed within the range (RSAT) at which its seeker becomes saturated.

<u>Maneuver State 87</u> - Break Lock

This missile in this maneuver state is flying a straight line course, by reason of having broken lock, or having had its seeker disabled by enemy action.

SECTION 5

SYSTEM REQUIREMENTS

The PACAM IV program is currently running on the CDC Series 6000 and Cyber 70 Computer Systems at ADTC and AFWL. The core requirement, expressed as an octal figure, is for 134 K words. This requirement could be reduced to less than 60 K by taking advantage of the CDC Segmented Loader.

Because the program is written in FORTRAN IV it should be possible to transfer it to another computer of comparable size and speed with a "reasonable" amount of effort.

APPENDIX

The following table lists the FORTRAN FORMAT statements which correspond to the various lines of the input forms.

Control Inputs (Form 1)	
Lines 1, 2	FORMAT(2A10/5I5,3F10.0)
Tactical Inputs (Forms 2, 3)	
Form 2, Line 1	FORMAT(10X,2(8X,I2,4X,A2,2(4X,I2)))
Form 2, Lines 2-7*	FORMAT(10X,I2,2(4X,I2,2X,3F6.0,2X))
Form 2, Line 8	FORMAT(2(2X,6F6.0,2X))
Form 2, Line 9	FORMAT(4X,2(2X,4F8.0,2X))
Form 3, Lines 1-6	FORMAT(4X,2(16X,6I2))
Form 3, Lines 7-12	FORMAT(5X,6(I2,1X,I2),10X,6(I2,1X,I2))
Aircraft Inputs (Forms 4-10)	
Form 4, Lines 1-3	FORMAT(1X,3(3X,I3),5X,I1/8(4X,F6.0))
Form 4, Lines 4-11	FORMAT(15X,4F6.0)
Form 4, Lines 12-15	FORMAT(10X,14F5.0)
Form 4, Line 16	~~FORMAT(14X,I6,3F10.0)~~ 8X,I2,7F10.0
Forms 5-10, Lines 1-3	FORMAT(26X,I2,29X,F8.0/1)
Forms 5-10, Lines 4-17	FORMAT(4X,F5.0,1X,14F5.0)
Missile Inputs (Forms 11-14)	
Form 11, Line 1	FORMAT(13X,I3,9X,I3,7X,2A10)
Form 11, Line 2	FORMAT(10X,5(F6.0,3X),4(3X,I3))
Form 11, Line 3	FORMAT(10X,7(F6.0,3X))
Form 11, Line 4	FORMAT(10X,2(2(F6.0,3X),9X))
Form 11, Line 5	FORMAT(13X,I3,3X,2(F6.3,3X),F5.0,3X,2 (F5.3,3X),I3,3X,F5.1,3X,I3)
Form 11, Line 6	FORMAT(19X,3(F6.0,3X))
Form 11, Lines 7-9	FORMAT(10X,14F5.0)
Forms 12-14, Lines 1-3	FORMAT(26X,I2,29X,F8.0//)
Forms 12-14, Lines 4-17	FORMAT(4X,F5.0,1X,14F5.0)
Screen Inputs (Form 15)	
Line 1	FORMAT(9X,I1)
Line 2	FORMAT(10X,4I8)
Lines 3-19	FORMAT(10X,4F8.0)
Lines 20-21	FORMAT(10X,4I8)
Lines 22	FORMAT(10X,4F8.0)

---

* For lines 1 and 2 dummy variables are read in place of RLIM, TAU1 and TAU2.

Detection Contours (Form 16) Lines 1-16	FORMAT(9X,I2/(10X,13F5.0)) (/9X, I2/(10X, 13F5.0))
Laser Inputs (Form 17) Lines 1-6	FORMAT(8X,8F9.0)
Initial Conditions (Form 18) All Lines	FORMAT(5X,I2,1X,A1,2X,3F6.0,2X, 4F4.0,2X,I2,3F6.0)